SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER 1903.

GENERAL PHYSICS.

862. *Dimensions of Units.* **L. Gorczyński.** (Phys. Zeitschr. 4. pp. 153–156, Dec. 1, 1902.)—This is a criticism of methods of basing all dimensions upon [L], [M], and [T], with special reference to Heat in which [θ] is required and to Electrostatics and Magnetism where [K] and [μ] are needed. In the latter, however, we may eliminate [μ] by using Laplace's equation, $dF = c.i.m. \sin a.dl/r^2$, whence—

$$[\mu] = L^{-2}T^2K^{-1} \text{ and } [m] = L^{3/2}M^{1/2}T^{-1}\mu^{\frac{1}{2}} = L^{1/2}M^{1/2}/K^{\frac{1}{2}},$$

and we thus reach a "magneto-electric" system. But, on the whole, it appears that [K] and [μ] cannot be expressed in terms of L, M, and T. A. D.

863. *Instrument for Drawing Sine Curves.* **A. S. Mackenzie.** (Phys. Rev. 13. pp. 366–367, Dec., 1902.)—Suppose one ruler of the pair in a parallel ruler to be fixed, and one of the connecting links made of a disc with a groove in its circumference to which one end of a string is fastened, and upon which the string winds (or unwinds) as the disc turns. When the disc rotates uniformly the free end of the string moves uniformly, and can be made to move a carriage sliding on the fixed ruler, at the same time the movable ruler has the up and down component of its motion simply harmonic. On transferring these two motions to a common point the latter will move in a sine curve. The above is the principle on which this instrument is constructed; for the way it is carried out reference must be made to the original paper.
E. C. R.

864. *Periodic Errors of Micrometer Screws.* **H. Rosenberg.** (Zeitschr. Instrumentenk. 22. pp. 246–254, Aug.; and pp. 269–275, Sept., 1902.)—If the reading of the screw head, *i.e.*, the angle of rotation, be denoted by L, and the correction to be applied for the periodic inequality is $\phi(L)$ then the latter can be expanded in a series of sines and cosines the values of the coefficients being obtained by the method of "least squares." For the determination of the periodic errors of the screw, readings L_i and L'_i are taken on the screw head, and the measured interval (f_i) between these readings is connected with the true interval (f_o) by means

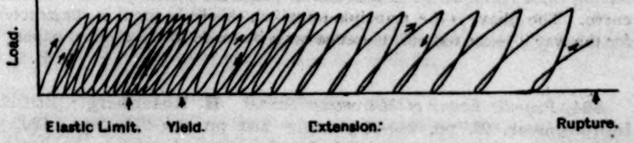
of the equation, $f_o - f_i = \phi(L_i + f_i) - \phi(L_i)$. A first approximation is obtained by neglecting the squares and products of the coefficients and counting f_o for f_i in the expressions *sin.* $\frac{1}{2} f_i$ and *sin.* f_i, and n equations of this type are obtained by taking values of i from o to n, for f_o, x_1, y_1, x_2, y_2. Errors of observation are then taken into account, and the equations are developed according to the method of least squares. Where the conditions permit of it, these equations can be greatly simplified by a cyclic arrangement of the measurements, *e.g.*, if the values of L_1 are taken at equal portions of the circumference of the screw head, say at intervals of $2\pi/n$. A second approximation is then proceeded with according to the special circumstances of the case.
E. S. A. R.

865. *Frequencies of a Horizontally Suspended Coiled Spring.* **F. J. Rogers.** (Phys. Rev. 15. pp. 374–379, Dec., 1902.)—The paper gives a comparison between theoretically calculated and experimentally observed values of the frequencies. The gravity effect is taken into account as well as the elasticity effect. The spring used consisted of 300 spires of No. 18 wire, each spire 5 cm. in diameter, total length of spring 2·4 m., suspended by 25 pairs of threads 60 cm. long. A mathematical theory is given leading to the frequency equation—

$$N_s = \frac{1}{2\pi}\sqrt{\frac{g}{l} + \frac{s^2\pi^2 F}{4ma^2}}$$

where a is length of coil, l length of suspending cords, m mass of spring per unit length, F force required to double the length of the spring, and the length from node to next antinode for the special harmonic N_s considered is a/s. The first part under the radical expresses the gravity effect, the second the elasticity effect. A table of values of the frequencies of the first ten harmonics is given, showing close agreement between calculated and observed values.
J. W. P.

866. *Repetition of Stress.* **F. Foster.** (Mech. Eng. 10. pp. 704–706, Nov. 22, and pp. 740–742, Nov. 29, 1902. Paper read before the Owens College Engineering Society.)—The author suggests a possible explanation of the phenomena caused by repetitions of stress in materials. If a bar receives by any mechanical process an elongation greater than that corresponding to the elastic limit under statical conditions, it will not return to its original form, having entered on the plastic state. Secondly, if a bar receives, in any mechanical way, a deformation equal to that causing fracture under statical conditions, then it will break. Also, if a bar be strained even within the elastic limit there is a time lag or hysteresis in its returning to its original form when the load is removed. If, then, we have a variation of stress from load to no load, the second cycle begins before the extension due to lag on the first cycle has had time to disappear; this produces a greater residual extension at the beginning of the third cycle, and so on, until the elongation becomes



equal to that due to the elastic limit, to the yield point, and finally to the statical elongation, and when this is reached the specimen will break. The diagram is intended to present qualitatively an idea of what is supposed to take place, the amount of lag being considerably exaggerated and the number of cycles shown in each part of the diagram having no quantitative signification. It is obvious that the greater the range of stress, the greater will be the lag per cycle of loading, and consequently the less the number of repetitions necessary to produce fracture. Increase of rapidity of repetition of the load would cause a diminution of the number of repetitions the specimen would stand before fracture, since the lag per cycle would be greater. It would be expected that of two bars having the same range of stress, the one having the higher mean value for the stress would require the less number of repetitions for fracture, since it has less of the elongation in the elastic stage to make up by means of the added lags. The author quotes figures and diagrams from the experimental results of Wöhler and others in support of his theory.
H. R. C.

867. *Stable Equilibrium of a Fluid.* **P. Duhem.** (Comptes Rendus, 135. pp. 1290–1293, Dec. 29, 1902.)—The author considers in this note a homogeneous incompressible fluid, whose elements are subject to forces derived from a potential V, and which is bounded by a surface S_0, on which the pressure is uniform and constant. Let n be the normal to S_0 measured inwards. Then he proves the following theorem: "If dV/dn is not negative at any point of S_0, and is positive at all points of a finite area Σ forming part of S_0, the equilibrium cannot be stable." He assumes an auxiliary function ψ, which satisfies the conditions following, namely: (1) At all points on S_0 $\frac{d^2\psi}{dt^2}+\frac{dV}{dn}\frac{d\psi}{dn}=0$. (2) At all points on Σ $d\psi/dn=0$. (3) At all points in the enclosed space $\Delta\psi=0$. (4) At all points in the enclosed space $d^2\psi/dt^2=0$ when $t=0$. Hence he proves that if $\Omega=\int\frac{dV}{dn}\left(\frac{d\psi}{dn}\right)^2 dS_0$, $d^2\Omega/dt^2$ can never be negative, and can be made to differ from zero, and is therefore positive, and so the equilibrium unstable. The method, he says, is applicable to the two following cases: First, the case of a homogeneous incompressible fluid at uniform constant temperature whose elements are subject to external conservative forces, its bounding surface being under uniform constant pressure. Second, a homogeneous compressible fluid under uniform constant pressure, and subject to no other external force, moving from a state of equilibrium in such way that the specific entropy is a function of the temperature or constant, the same at all points of the fluid. These are, he says, precisely the cases in which the method of Lagrange and Lejeune-Dirichlet enables us to determine the conditions for stability. But they are not precisely the conditions assumed in this paper. The problem of determining the necessary and sufficient conditions is yet, he says, far from being solved. S. H. B.

868. *General Equations of Motion of a Rigid Body.* **A. Wassmuth.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 777–787, May and June, 1902.)—The writer begins with a reference to Kirchhoff's work (Mechanik, 4 Aufl., 1898, 5 and 6 Vorlesung), and points out the great difficulty of the investigation therein contained. In the special case where one point of the body is fixed, we cannot take for independent variables the three angular velocities p, q, r, because, as Routh has shown, the co-ordinates of each point of the body cannot be expressed in terms of p, q, r, without introducing into the geometrical equations differential coefficients according to the time. He proposes a new method. The position of the body is given if we know the co-ordinates α, β, γ, of a point G in the body referred to rectangular axes fixed in space ($\xi\eta\zeta$) and the nine direction cosines of three rectangular axes through G fixed in the body. Between these nine variables exist six relations, which, when Lagrange's equations come to be applied, give rise to six indeterminate multipliers $\lambda_1 \lambda_2 \ldots \lambda_6$. From these data he finds an expression for U′, the work done by the forces, which leads to three Lagrangian equations of the form $d/dt \,.\, d\mathrm{T}/d\xi = .\,\Xi$, &c. To find the other nine he introduces the six given conditions—

$$a_1^2 + a_2^2 + a_3^2 = \mathrm{F}_1 = 1, \text{ \&c.},$$
$$a_1 a_2 + \beta_1\beta_2 + \gamma_1\gamma_2 = \mathrm{F}_2 = 0, \text{ \&c.},$$

in the form—

$$\frac{d}{dt}\left(\frac{d\mathrm{T}}{ds'}\right) - \frac{d\mathrm{T}}{ds} + \lambda_1 \frac{d\mathrm{F}_1}{ds} + \lambda_2 \frac{d\mathrm{F}_2}{ds} + .\,\text{\&c.} = \mathrm{S},$$

where S stands in succession for the nine direction cosines $a_1 \ldots \gamma_3$. By these substitutions he obtains three equations—

$$\frac{d}{dt}\left(\frac{d\mathrm{T}}{d\dot{a}_1}\right) - \frac{d\mathrm{T}}{da_1} + 2\lambda_1 a_1 + \lambda_3\gamma_1 + \lambda_6\beta_1 = \mathrm{A}_1.$$
$$\frac{d}{dt}\left(\frac{d\mathrm{T}}{d\dot{a}_2}\right) - \frac{d\mathrm{T}}{da_2} + 2\lambda_1 a_2 + \lambda_5\gamma_2 + \lambda_6\beta_2 = \mathrm{A}_2.$$
$$\frac{d}{dt}\left(\frac{d\mathrm{T}}{d\dot{a}_3}\right) - \frac{d\mathrm{T}}{da_3} + 2\lambda_1 a_1 + \lambda_5\gamma_3 + \lambda_6\beta_3 = \mathrm{A}_3.$$

Hence he deduces Kirchhoff's equations 14 of the 6th Vorlesung, also equations 12 and 13, and finally obtains the most general equations of the first kind for the motion of a rigid body. For example (18)—

$$\frac{d}{dt}\left(\frac{d\mathrm{T}}{d\dot{a}_1}\right) = \frac{d}{dt}\left(a_1 \frac{dt}{du} + a_2 \frac{dt}{dv} + a_3 \frac{dt}{dw}\right) = \Xi, \text{ \&c.}$$

The quantities λ are shown to be moments of rotation. S. H. B.

869. *Stability of Equilibrium in a Viscous System.* **P. Duhem.** (Comptes Rendus, 135. pp. 939–941, Dec. 1, 1902.)—A material system has utilisable energy (denoted by Λ) whenever the following equation is satisfied, namely: $d\mathrm{T}_e + d\mathrm{T}_p = d\Lambda + d\Theta$, in which Θ is the kinetic energy, T_e the internal work, and T_p the internal work due to viscosity. Such systems are called by the author isothermo-adiabatic. Systems in which all the changes are isothermic or iseutropic are of this nature. If Λ exists, let P be the potential of external force, and $\mathrm{P} + \Lambda = \Omega$. Then by the Lejeune-Dirichlet theorem the system is in stable equilibrium when Ω is minimum. The question discussed in this paper is whether it is unstable when Ω is not minimum, but its first derivative is zero. By a suitable choice of the variables $\xi_1 \ldots \xi_n$ which define the system, we can always satisfy the conditions. (1) Equilibrium corresponds to $\xi_1 = .. = \xi_n = 0$; (2) in equilibrium $\Omega = 0$; (3) $\Theta = \xi_1'^2 + . + \xi_n'^2 + \&c.$; $\Omega = \mathrm{S}_1\xi_1^2 + . + \mathrm{S}_n\xi_n^2$. Liapounoff and Hadamard have proved in the works to which the author refers that if at least one of the coefficients S is negative, the system is in unstable equilibrium. But that is in the absence of viscosity. It is suggested that it might be rendered stable by viscosity. The writer has not completely proved for this case the theorem analogous to that of Liapounoff and Hadamard, but he establishes the following: If one at least of the coefficients S is negative, and if none of them is positive the equilibrium is unstable. This is proved by the use of the dissipation function of Stokes and Rayleigh. If $V = \Sigma(\xi'^{2}_{p} - S_p \xi_p^2)$, he proves that d^2V/dt^2 is positive.

S. H. B.

870. *Stability of Equilibrium of Variables without Inertia.* **P. Duhem.** (Comptes Rendus, 135. pp. 1088–1091, Dec. 15, 1902.)—This is a continuation of a former paper [see preceding Abstract]. He proved in the former paper a theorem converse to that of Lejeune-Dirichlet, assuming viscosity to exist. But the proof was based on the assumption that the kinetic energy contained the time differential coefficients of all the variables. This, he points out, is not the case in thermodynamics. In systems there treated there are variables without inertia, whose first derivatives do not enter into kinetic energy. He here calls such systems those of Chemical Mechanics. As the variables having inertia appear in the kinetic energy but not in the dissipation function, so as regards the variables without inertia the opposite is true. He now assumes the system to be determined by two sets of variables, namely, $\xi_1, \xi_2 \ldots \xi_m$ having inertia, and $\eta_1, \eta_2 \ldots \eta_n$ without inertia. The conditions (1), (2), (3) of the former paper now become: (1) In equilibrium $\xi_1 \ldots \xi_m = 0$, $\eta_1 \ldots \eta_n = 0$; (2) $\Omega = 0$; (3) $\Theta = \Sigma\xi'^2$, $F = \Sigma\eta'^2$; $\Omega = S_1\xi_1^2 + \ldots + S_m\xi_m^2 + \sigma_1\eta_1^2 + \ldots + \sigma_n\eta_n^2$. And he proves as in the former paper that $d^2V/dt^2 > 0$, if one only of the coefficients S_1 σ is negative.

S. H. B.

871. *Volcanic Eruptions on Martinique.* **Lacroix.** (Comptes Rendus, 135. pp. 1301–1307, Dec. 29, 1902.)—During November and December the author several times saw dark, dense, enormous vapour clouds, in constant movement like balls of cotton, roll down the Mt. Pelée to the sea, traversing the distance of 6 km. in six or nine minutes, and darkening the sea on which they disperse for several hours. While descending they also rose slowly to an elevation of 3,000 m. They carry with them ashes and also lapilli and lava in large quantities; the ashes are white and exceedingly fine. From the same part of the cone where the vapour clouds issue, come also, sometimes without interruption, incandescent blocks which break up as they roll down the mountain; they are not thrown up high by the volcano, no explosive eruptions having been noticed in those weeks. The block fragments near the sea are up to 100 m. in size. H. B.

872. *Free Hydrogen in the Atmosphere and the Density of Atmospheric Nitrogen.* **A. Gautier.** (Comptes Rendus, 135. pp. 1025–1032, Dec. 8, 1902.)—The author's estimate of the amount of free hydrogen contained in the atmosphere—about 0·0002 of the volume—having been questioned by A. Leduc and Rayleigh [see Abstract No. 751 (1903)], the author replies to these criticisms. He finds fault with Leduc's method of calculating, charging him with inconsistency as regards the meaning of the density of atmospheric nitrogen. Rayleigh's objections were based on comparative spectroscopic tests and on direct combustion tests; the latter the author criticises as discordant in themselves. The author finally regrets that, in spite of Regnault's warnings, densities are still referred to air as unity; the density of the air varies with the locality, town or country, mountain or sea, as he has shown. He does not mention any fresh experiments. H. B.

873. *Pre-determination of the Air Pressure Variations for the following Day.* **F. M. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 707–725, May and June, 1902.)—From the data of the synoptic charts of one day the author deduces a merely hydrodynamical, differential equation, not permitting of integration for the air currents of the following day. Thermal influences are not allowed for; the rotation of the earth and dynamical friction are considered. The author points to the peculiar influence of mountain barriers. When a south wind blows over Italy, the isobars are bulged out (towards S.E.) on the eastern coast of Italy, marking a relative depression there which is not noticeable on the west coast and on the Dalmatian coast; with a north wind, the depression appears on these latter coasts. The formula is tested for Vienna, Paris, Stockholm, &c., with satisfactory results. The computation of the constants would, however, be very tedious, though the constants seem to be principally the same for all isobar configurations, and affected only by the geographical influences which vary with the wind direction. H. B.

874. *Similarity of Short-Period Pressure Variations over Large Areas.* **N. Lockyer** and **W. J. S. Lockyer.** (Roy. Soc., Proc. 71. pp. 134–135, Dec. 27, 1902.)—The authors have continued the investigations mentioned in Abstracts Nos. 198 and 291 (1903) on the existence of a short-period oscillation of barometric pressure corresponding with a variation in the percentage number of prominences. The monthly means of pressure variations for each station are divided into two periods, namely, months in which the pressures are above, and those in which they are below the normal. The investigation now concerns India, Ceylon, Java, Australia (Perth, Adelaide, Sydney), Cordoba in South America, and a corresponding region north of the equator, namely, Mobile (Alabama), Jacksonville and Pensacola (Florida), and San Diego (California). In southern latitudes the high pressure months are generally April to September, in northern October to March. Comparison of the curves, in most places covering the period 1875 to 1900, is to show that the pressure variations over large areas are similar, but the inverse of those recorded in nearly antipodal parts, so that the same kind of variations would be in action over northern and southern latitudes. H. B.

875. *The Meteorological Effects of the Solar and Terrestrial Physical Processes.* **F. H. Bigelow.** (Monthly Weather Rev. 30. pp. 559–567, Dec., 1902. Paper read before the Physics Section, B, of the A. A. A. S. at the Washington, D. C., Meeting, Dec. 28, 1902.)—The author gives an explanation of the double diurnal periods in the meteorological elements in the atmosphere at the earth's surface. At some distance above the ground the periods are all single, and these he considers to be due to the effects of the incoming solar radiation, while at the earth's surface the two periods are due to the added effect of the terrestrial radiation. Calculated on the Wien-Paschen formula, curves are given of the solar and terrestrial radiation for different temperatures, the former being reduced to the distance of the earth. The maximum radiation of the earth consists of waves of about 8 to 10 μ which are specially readily absorbed by the aqueous vapour in the air, and the increase of temperature causes the vapour layers to rise, their place being filled by surface evaporation. At noon, as the whole temperature rises, the vapour capacity rises, and as the surface evaporation has become slower owing to the prevailing moisture having been taken up at an earlier hour, the surface air volumes become depleted of moisture; a minimum in the humidity curve therefore occurs at about 3 p.m. The second maximum is due to the processes taking place in the reverse direction. Similar reasoning is applied to explain the other diurnal curves. E. C. C. B.

876. *Cloudbursts.* **A. D. Elmer.** (Monthly Weather Rev. 30. p. 478, Oct., 1902.)—Cyclonic thunderstorms as a rule move slantingly. If we imagine the storm area to be rectangular, then it may move broadside on, longitudinally, or slantingly. In the first case, the observer experiences a tornado of short duration, and there is not much rain on the spot; the case is rare. In the second case, the storm travels slowly along its long axis; the observer experiences a calm, and very heavy rain continues for a long time. This is what people call cloudbursts. The author has observed two such storms rising to 1,400 and 2,500 ft. respectively. H. B.

877. *Cycles of Precipitation in Utah.* **L. H. Murdoch.** (Monthly Weather Rev. 30. pp. 482–485, Oct., 1902.)—The Great Salt Lake is the remnant of an enormous lake basin which must at one time have been 1,000 ft. deeper than at present. The author finds that since 1856, and probably since 1827, the level of the lake and the precipitation curves have kept fairly parallel; but since 1889 the lake level has steadily decreased, while the rainfall has not much changed. For Salt Lake City, there was a dry cycle from 1827 to 1864 (average annual rainfall 15 in.), a wet cycle from 1865 to 1886 (average 18·4 in.), and a dry cycle again from 1887 to 1901 (rainfall 15 in.). H. B.

878. *Meteorology of the Equator at Pará and Gaboon.* **J. Hann.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 615–683, May and June, 1902.)—The paper is essentially a discussion of the data collected by E. Goeldi in Pará (Brazil) during the years 1885 to 1901, supplemented by observations taken by E. Engelenburg during the magnetic survey of North-east Brazil in 1883–84. Detailed comparative references are made to the meteorology of the estuary of the Gaboon (opposite Pará, in West Africa) as recorded by Soyaux, A. von Danckelman, and also by Vincent; further, to the Island of S. Thomé (Gulf of Guinea), Equateurville (Congo State), and Quito. The climate of Pará is remarkably equable, the monthly temperature means do not differ by more than 1·4°C.; even the monthly extremes remain the same for years. The variations of the barometer show no connection with the cloudiness and rainfall; the diurnal variations are similar to those at Gaboon, but smaller. The mean barometer at Pará is 758·3 mm., just as at Guyaquil, on the East Coast of South America, 758·0 mm. The mean annual temperature of Pará is 25·7° C., 2° lower than the figure of the *Challenger* reports; the author considers that most equatorial temperatures have been over-rated. The daily variation is about 9°; the mean temperature remains constant from May to September; the maximum occurs when the sun is the second time in the zenith, the minimum coincides nearly with the first zenith position; this is not so at Gaboon. The relative humidity is always high at both places and varies more at Gaboon; in the mornings and evenings the air is saturated with moisture. The cloudiness is greater at Gaboon than at Pará. There is a kind of rainy season at Pará from January to April, followed by a drier period to December, during which rains are also frequent, however. Thunderstorms occur on 170 days at Pará, mostly in the afternoons, and these storms begin later as the year advances, at 3·4 h. in January and at 5·6 h. in September. The average daily rainfall is 9 mm. at Pará (131 mm. maximum), 13 mm. at Gaboon (153 mm. maximum). Winds from

north-east and east predominate at Pará; there is no regular diurnal change in the direction of the winds, but there is in their force. At Gaboon, south-west winds prevail; and their direction changes in the course of the day.

H. B.

879. *Meteorology of Geneva and the Great St. Bernard in* 1901. **R. Gautier.** (Archives des Sciences, 14. pp. 564–589 and 601–608, Nov.; and pp. 650–687, Dec., 1902.)—The observations, referred to in Abstract No. 646 (1902), have been continued on the same plan. The averages are computed, as before, both for the civil and the meteorological year. On the St. Bernard seven readings are taken daily in the old station, and three with thermometers and hair hygrometers in the new station; the observers are Prior Gard and the brothers. The difference between the two sets of thermometers amounts to 0·46° maximum. The year was rather wet and cold, particularly on the St. Bernard, where a hot summer was more than counterbalanced by the other cold seasons; in Geneva both autumn and winter were cold. February was the coldest month with mean temperatures of — 2·34° (Geneva) and — 15·28° (St. Bernard); July the hottest, means + 19·25° and + 6·91°. The extremes were — 14° and + 31·2° (Geneva) and — 26·4° and + 19·5° (St. Bernard). The amplitudes of the extreme pressure variations differ a little more from the averages of Plantamour, but are not striking either. The pressure means, based upon eight, and upon three, daily observations respectively, in no case differ by as much as 0·1 mm. The new hair hygrometers on the St. Bernard recorded zero humidity twice on November 21, 1901. May is the driest month in Geneva, October on the St. Bernard. In Geneva sunshine is more frequent in the afternoon than in the morning, and the wind velocity twelve times exceeded 25 km. H. B.

880. *Anomalous Dispersion Theory of Sun's Chromosphere.* **W. H. Julius.** (Phys. Zeitschr. 4. pp. 132–136, Nov. 15, 1902.)—The objections to the above theory raised by Wilsing and others are discussed, and it is concluded that the light from the chromosphere and the protuberances is to be ascribed almost exclusively to anomalous dispersion, and only in a small degree to general refraction. G. E. A.

881. *Theory of Solar Protuberances.* **W. H. Julius.** (Archives Néerlandaises, 7. pp. 473–483, 1902.)—This is an attempt to explain the nature of solar protuberances by anomalous dispersion. In former papers [see Abstracts Nos. 33 (1901) and 25 (1903)] the author had suggested the following hypothesis relative to the constitution of the part of the solar atmosphere exterior to the so-called photosphere: The various elements, the presence of which in the atmosphere of the sun has been inferred from spectral analysis, are much more widespread than had formerly been assumed on the nature of luminous phenomena. They may occur even over great distances beyond the photosphere, and still be visible only at some places, their own radiation contributing very little towards rendering them visible; the distances beyond the edge of the disc of the sun at which the characteristic light of the substances is seen is mainly determined by local variations in their density, in connection with their property of giving rise to anomalous dispersion. No hypothesis as to the origin of chromospheric light had been made, as nothing had been said about the interior of the photosphere. In order to continue these considerations, the author makes use of the three propositions by which Schmidt resumes the principal points of his theory, according to which the

surface of the photosphere is not the limit of a body but a sort of *critical sphere*, defined by the property that its radius is equal to the radius of curvature of the horizontal light rays passing through a point of its surface. On this theory, not only the edge of the photosphere is formed by regular reflection, but even the protuberances would be produced by reflection in the "*Schlieren*." Now, in order to account for the fact that the light from these protuberances and from the chromosphere is not white, but shows a line spectrum of variable aspect, Schmidt considers the strongly radiating part of the gaseous mass to be constituted so that the exterior part would emit almost exclusively the light of hydrogen, calcium, and helium, whereas sodium, magnesium, titanium, and iron radiations would come from the inner layers. By the use of the principle of anomalous dispersion it is, however, possible to assume that the mixture of various substances is present in the whole of the gaseous mass, inside as well as outside of the critical sphere. Wherever streams, vortices, &c., give rise to differences in the density of the gaseous mixture, the conditions for an irregular curvature of the rays are given, it being evident that out of the substances present in the mixture those possessing very strong specific dispersion for certain kinds of the transmitted light will be detected over particularly wide distances beyond the solar disc, whereas others, though equally present, will remain invisible. The fact that various gases of the sun appear to be separated, though no real separation is presumed, is thus accounted for in a purely optical way. This latter hypothesis, he also shows, is a necessary consequence of the representation of the sun as a gaseous, rotating mass giving off heat, as a continuous mixture of the elements such a body is made up of must of necessity take place. Similar considerations have been suggested by R. Emden [see Abstract No. 1086 (1902)], and some mathematical deductions as made by Helmholtz apply to the phenomena occurring on the sun, though Emden admits the mass of the sun to be limited by a surface in accordance with the views most generally adopted. As, however, his mathematical considerations are quite independent of the existence of such a limit, they may equally well be applied to a sun such as defined by the author. The external layers of the gaseous mass being most rapidly cooled by radiation, will gradually descend, and be replaced by rising gases, being warmer, so that, but for the rotation of the sun, only radial currents would be met with. On account of the rotation about the axis, these currents, however, are considerably modified, the angular velocity of the descending masses increasing, whereas that of the rising masses will be diminished ; gaseous layers of different densities, rotating at different speeds, are thus obtained beside one another. As shown by Helmholtz, such gaseous layers are susceptible of a relative motion for some time, without their becoming intermixed ; on account, however, of the friction, this surface gradually takes the form of a wave surface, the waves being propagated along with the layer, the velocity of which is most considerable, so as to form by the mixture of two neighbouring surfaces a new layer, the properties of which will, as a rule, be intermediate between the corresponding properties of the primitive layers. The behaviour of these surfaces has been deduced by Emden in a manner similar to what has been done by Helmholtz in the case of the currents of atmosphere, the result being arrived at that the surfaces of discontinuity will have a form similar to a hyperboloid of revolution. It may, however, easily be understood that similar surfaces will nowhere occur in the whole of their extension, but fragments of such surfaces, the general character of which will be the same, are likely to be met with everywhere. Though a continuous mixture, compensating differences in speed will take place, the state of motion must somehow remain stationary; inside of each layer, temporarily included between two surfaces of discontinuity, convection currents will continuously convey cool substance downwards, warm matter rising at the same time, so as to re-establish continuously the differences in speed. The author now contends that the whole of the chromosphere with all its protuberances is constituted by this system of waves and vortices made visible up to distances more or less great beyond the edge of the sun, in virtue of the anomalous dispersion of the photospheric light. The chromosphere is ascribed to the relatively small vortices, the continuous winding-up of the surfaces of discontinuity, whereas the protuberances are regarded as the vortices the very great waves of the solar sea are transformed into. Many instances in favour of these views are derived from a recent paper by Fényi. On the above theory many apparent contradictions afforded by the enormous velocity of propagation of solar protuberances are easily done away with. In fact, the term velocity may be applied only to a displacement of matter or to the propagation of a chemical phenomenon, or finally, of a state of movement. Nothing of the kind, however, is met with in the present case, as the formation of vortices takes place only under the influence of the local state of the matter, and is not due directly to a similar motion pre-existing at other places. The phenomena in question are comparable to the propagation of the waves of the sea, where also there is no velocity proper. A. G.

882. *The Meteorite of October* 3, 1901. **G. v. Niessl.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 1074–1131, July, 1902.)—The meteorite was seen at 7 h. 22 m. in the evening (Central European time) over an area of 800 by 630 km., extending from the Northern Adriatic to Magdeburg. The author examined more than two hundred accounts, partly reproduced in the paper. Although they differ widely, some parts are fairly settled. First seen in Pegasus as a shooting star at a height estimated by the author at from 100 to 315 km., the meteorite increased rapidly in brilliancy and size as it descended almost vertically. The light is described as resembling that of an arc lamp, or greenish or bluish, the shape as that of a ball (half to twice the size of the moon) with conical projections, or of a pear; a trail was observed. The meteorite seemed to stop and to separate into several parts—but the accounts disagree strangely on this point; the colour changed to red; the reports of fragments found and detonations are unreliable. The stopping took place above Jessenitz, in the centre of Bohemia, at a height computed at 42 km.; the fall lasted about four seconds at a rate of 34 km. per second. The author believes that the meteorite consisted, as usually, not of one mass, but of a cloud of particles; the finer particles quickly passed through incandescence, then disclosing the reddish, coarser particles inside. This would be the apparent explosion; the increase in size was probably real, and the character was about 1,250 m. The cosmical radiating point is computed at 287·7° longitude, and 30·2° northern latitude (ecliptic), that is a spot not very far from the apparent apex of our solar system. The author points out that this radiant would fit many of the shooting stars and meteorites, apparently starting from different portions of the sky in different seasons. H. B.

LIGHT.

883. *Light Scattered and Transmitted by Fine Particles.* **J. Barnes.** (Phys. Rev. 15. pp. 868–873, Dec., 1902.)—When a ray of sunlight is passed into a tank of distilled water to which a few drops of an alcoholic solution of mastic have been added, Tyndall's blue cloud effect is obtained, the beam being of a more decided blue at the beginning than at the end. With a larger quantity of mastic in suspension, the light scattered from the end of the path is a dim red. The part of the incident light cut off in transmission was ascertained by passing the beam of sunlight through a Steinheil spectroscope with the telescope removed. The rays then passed into a rectangular tank so that the water surface divides the spectrum in two. It was found that for $\lambda = 410$, $xn^{2 \cdot 5} = $ constant, where x is the distance penetrated, and n is the amount of mastic solution present which may be taken as proportional to the number of particles present. With increase of wave-length the exponent of n approaches unity. G. E. A.

884. *Primary Colour Sensation.* **F. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 857–877, May and June, 1902.)—The three curves of primary colour sensation of the Young-Helmholtz system cut each other in four points, *a*, *b*, *c*, and *d*, beginning at the red. The point *a* corresponds to the colour complementary to primary blue, *b* gives the wave-length of primary green, *c* the complement to red, and *d* the wave-length of primary blue. A spectrum 1 metre long, formed by means of an arc lamp and a large concave grating, was observed through a dichroscopic lens, a large nicol being placed between the lens and the eye. On turning the nicol from the position for equal brightness, the dark and bright halves of the field changed colour in opposite senses for positions on opposite sides of the point *a*. The points *a*, *b*, &c., were thus determined within narrow limits, the mean results for four observers being, for *a*, *b*, and *d*, λ577, 508, and 475, and for *c*, by the author's observations, λ494. The method is free from the somewhat debatable assumptions which underlie the methods of König and Dieterici. G. E. A.

885. *Phenomena of Radiation.* **L. Graetz.** (Phys. Zeitschr. 4. pp. 160–161, Dec. 1, 1902.)—As against J. W. Russell's explanation of the action of certain metals and substances upon photographic plates as being due to H_2O_2 (Proc. Roy. Soc. 64. 409, 1899), the author shows that the actions referred to traverse thin layers of gold or aluminium, and that they remain even when all H_2O_2 vapours are driven away by a strong blast of air. They are not due to negative electrons. They travel in straight lines until they reach the photographic plate, but then there is no regular reflexion. A plate is exposed to H_2O_2 vapours and then a metallic object is laid on the glass side of the plate; on developing the plate the metallic object appears bright on a dark ground. The effect of the metallic object is not destroyed by interposing black paper, ebonite or wood between it and the glass, and intervening liquids rather heighten the effect sometimes. Water has this effect; so have saline solutions, alcohol, and especially ammonia. If a plate has figures drawn on its glass side with a match dipped in water or ammonia, and be then exposed on the film side to H_2O_2 vapours, these figures come out dark and rather diffuse upon development. Laying metallic objects upon wet paper on the glass side brings out differences between the effects of the different metals scarcely perceptible in the absence of the wetted paper; and this serves as a means of detecting the slightest chemical action between the metal and the solution with which the paper is wetted. The cause seems to be the resultant rise in temperature, even though this do not exceed 0·01 to 0·02°, the warmer part developing out thinnest. This method opens up a method for photography of the infra-red spectrum under the influence of H_2O_2 vapours or rather of unknown emanations from these. A. D.

886. *Sensitometry of Photographic Plates.* **J. M. Eder.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 888–893, July, 1902.)—Experiments on direct blackening of Ag Br films sensitised by dye-stuffs. An erythrosin-dyed plate (Schattera's) gave results when exposed to the spectrum (minutes to hours) astonishingly like those obtained from short exposures followed by development. Eosin dye-stuffs in general have this effect; as also strong cyanin solution, formyl-violet, cyclamin, and chinolin-red, but not alizarine-blue-sulphite. Schattera's plates sensitised for red did not give this result: it gave green, not black, and that only in the blue and violet; but where a black colour is produced directly by exposure, the rule applies that for many dye-stuffs the results of direct exposure, or of short exposure and development, are approximately the same; but the blacks obtained by development may be far denser than those obtained by direct exposure, which for erythrosin-dyed plates must be from 10,000 to 20,000 times the exposure required for subsequent development. [See also Abstract No. 214 (1903).] A. D.

887. *Photographic Dry Plates.* **K. Schaum** and **V. Bellach.** (Phys. Zeitschr. 4. pp. 190–194, Dec. 15, 1902.)—This is a continuation of a former paper [see Abstract No. 793 (1903)]. Where the Ag Br granules in a dry plate (Schleussner Normal) were 270,000 per sq. mm. in the superficial layer, the granules of silver in the developed plate did not exceed 82,000; there was some agglomeration, but many of the particles escaped development altogether. The size of the silver particles increases with the exposure (both as to duration and as to brightness) and with the duration of development. Long development may make the Ag granules larger than the original Ag Br granules. When the plate is solarised the average size of the granules is smaller than under normal exposures, and it decreases with increasing solarisation. When the plate is exposed, fixed and then developed (secondary development, in Neuhauss's developer, water 100 c.c., $AgNO_3$ 4 grm., ammonium sulphocyanide 24 grm., sodium sulphite 24 grm., sodium thiosulphite (hypo) 5 grm. KBr 10 per cent. solution six drops; of this take 3 vols., add 27 of water and 1 of rodinal, the size of the granules depends not only on the exposure but also on the duration of the development. Candle at 2 metres 10 to 50 secs., development 17 hours, granules 1·0 to $1{\cdot}7\mu^2$; 50 secs. at 2 metres, development 24 and 48 hours, silver granules 0·9 and $2{\cdot}1\mu^2$ respectively. The granules under this method are nearly spherical instead of being irregular in form. The opacity of a negative depends not only upon the number and the distribution of the silver particles, but also on their size, which depends upon the ripening of the plate, the exposure, and the mode of development. A. D.

888. *Magnetic Rotation of the Plane of Polarisation in Liquid Oxygen.* **F. Harms.** (Phys. Zeitschr. 4. pp. 158–160, Dec. 1, 1902.)—The author has determined the order of magnitude of the Verdet constant for liquid oxygen. The oxygen was contained in a brass vessel surrounded by jackets

of liquid air and placed between the poles of a Ruhmkorff electromagnet. The polarised light was reflected back to the analyser from a mirror placed at the bottom of the oxygen. Carbon bisulphide (and also benzene) was examined in the same apparatus, with the result that the value of $a0_2(\text{liquid})/a_{CS_2}$ was found to be 0·20, with a possible error of 10 per cent.; this value is in accordance with the view that Becquerel's formula, $a/a_{CS_2} . 1/n^2(n^2-1) = K$, is applicable to oxygen (as to carbon bisulphide and sulphur dioxide) in both the liquid and gaseous states. The following modification of a table drawn up by du Bois contains the value of the Verdet and derived constants for oxygen and other substances: x is the magnetic susceptibility, ω is the Verdet constant in c.g.s. units, $\phi = \omega/x$ for feebly magnetic substances, $\phi = \omega(1 + 4\pi x)/x$ for strongly magnetic bodies.

	$x \times 10$	$\omega \times 10^5$	ϕ
Fe	—	—	+ 2·63
Ni	—	—	+ 3·15
Co	—	—	+ 3·99
O_2 (liquid)	+ 22·8	+ 0·24	+ 0·011
$FeCl_3$ (40 per cent.)	+ 6·4	− 2·4	− 0·38
O_2 (1 atmos.)	+ 0·0126	+ 0·000179	+ 0·014
C_2H_5OH	− 0·0566	+ 0·330	− 5·8
H_2O	− 0·0694	+ 0·377	− 5·4
CS_2	− 0·0716	+ 1·222	− 17·1

D. H. J.

889. *Rotary Polarisation and Convection.* **Rayleigh.** (Phil. Mag. 4. pp. 215–220, Aug., 1902.)—The question as to whether the rotation of the plane of polarisation of light propagated along the axis of a quartz crystal is affected by the direction of this axis relatively to that of the earth's orbital motion, was considered some time ago by Lorentz. He arrived theoretically at the conclusion that a first order effect might be anticipated, and that the effect of changing the direction from coincidence with the earth's direction of motion to the reverse might amount to 1/10,000 of the whole rotation. The author describes a very carefully made experimental test, in which the rotation produced exceeded 15 complete revolutions. The result showed that there was certainly not a difference amounting to as much as 1/20 of a degree, *i.e.*, 1/100,000 of the whole rotation, and that in all probability, if such an effect existed at all, it was for smaller than this. Larmor criticised Lorentz's conclusion in "Æther and Matter," but Lorentz [see Abstract No. 1680 (1902)] maintains his conclusion. G. W. de T.

890. *Rotary Polarisation and Convection.* **J. Larmor.** (Phil Mag. 4. pp. 367–370, Sept., 1902.)—In this paper the author admits the validity of Lorentz's reply to his criticism, referred to in the preceding Abstract. The latter showed that, while convection would not affect the coefficient of magnetic rotation, it would modify the structural coefficient. The author points out that Rayleigh's result therefore tends to show that in the more complex circumstances of rotational media, as well as in ordinary optical propagation in matter, the electrons connecting matter and ether interact in all their relations according to laws of purely electrodynamic type. The atomic character of electrification, with or without a distinct material basis, has the effect that when the medium is convected the electrons exert the ordinary electrodynamic influence of moving charges. Uniform convection will, therefore, produce no first order effects on the electrical and optical properties of media. He considers it to be established that there will be no second order effects if material molecules are entirely electric. If this is the case, it would account for the negative second order observation of Michelson and Morley. G. W. DE T.

891. *Thermal Development of the Spark Spectra of Carbon.* **H. Crew** and **J. C. Baker.** (Amer. Acad., Proc. 38. No. 12. pp. 397–406, Dec., 1902.)—An electric arc was first developed between two carbon poles, and when these were thoroughly hot the arc was stopped and the spark was turned on; as the electrodes cooled, the character of the spark changed slowly from the arc to the spark discharge. The spectrum of the spark was photographed at definite intervals after the spark had been turned on. Exposures of one second were given, and the whole cycle, including the exposure, was automatically repeated many times in order to ensure sufficient density in the photograph. The region of the spectrum examined was between $\lambda = 4500$ and $\lambda = 3000$, and the following are the chief results that were obtained. The cyanogen bands are present with the same relative intensity at all the stages. Carbon lines are few in this region; the line at $\lambda = 4556{\cdot}3$ does not appear in the hot spark, not does the line at $\lambda = 4267{\cdot}5$, and as the latter disappears from the cold spark when self-induction is introduced it is probable that it does not belong to carbon. The line at $\lambda = 3361$ is persistent in the hot spark, and as to the remaining lines at $\lambda = 3920$, 3877, and 3840, they could not be recognised. The air lines do not appear with the hottest spark, but only appear on cooling, while the nitrogen flutings behave in an exactly opposite manner. Of metallic lines the two strongest are the two potassium lines at $\lambda = 4047{\cdot}3$ and $4044{\cdot}3$, but these only appear in the hot spark. Some lines of an element may be enhanced on cooling and others diminished, but lines belonging to one natural series are all similarly affected. E. C. C. B.

892. *Flame Spectra.* **C. de Watteville.** (Comptes Rendus, 135. pp. 1329–1332, Dec. 29, 1902.)—The author has examined the flame spectra of metallic salts produced in the inner core of a bunsen flame, and finds that the results are different from those usually obtained, the lines in the new spectra not being visible in the ordinary flame spectra. These results confirm Gouy's observations (Ann. Chim. et Phys. 18, 1879), and the experimental methods were the same as those employed by him. Salts of about nineteen metals were tried, and the spectra were photographed by means of a Rowland grating, and the following results obtained. The spectra extended some distance into the ultra-violet: for example, the tin line at $\lambda = 2269$ was visible. All the lines observed are common to the arc and spark spectra, but the characteristic spark lines were not present in the flame spectra. The strong arc lines, however, were to be found with the same relative intensities upon the plates. The flame spectra and the oscillating spark spectra (Hemsalech) are identical, with the exception of a few rays in the latter, which were probably too weak in the former to affect the photographic plate. This similarity is especially pronounced in the case of iron, nickel, cobalt and manganese, the two spectra being in certain regions undistinguishable. The author concludes that the temperature is the only factor which determines the nature of the spectra. E. C. C. B.

893. *Photo-electric Activity of Substances Coloured by Becquerel Rays.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 4. pp. 113–114, Nov. 1, 1902.)—

Photo-electric dispersion of negative charges decreases with increasing wave-length of the incident light, so that the list of substances presenting this property rapidly diminishes with increase in this wave-length. For ultra-violet light it is almost a general property of matter: for sunlight and diffused daylight the list is Zn, Mg, Al, Na, K, Ru, Cs and their amalgams, phosphorescent sulphur compounds of the alkaline earth metals, and halogen compounds of the alkali and alkaline earth metals which have a colour occurring naturally (blue fluorite) or induced by the action of K or Na vapours on the uncoloured salts; as also chlorides and other salts coloured in an analogous way by the action of Becquerel rays or of radium emanations, the colours produced being often so fugitive that they are completely discharged in the course of the experiment under the influence of sunlight or daylight. A. D.

894. *Radio-Active Emanations from the Soil.* **H. Ebert** and **P. Ewers.** (Phys. Zeitschr. 4. pp. 162–166, Dec. 1, 1902.)—The radio-active air from the capillaries of the soil can be removed in metal tubes and kept in zinc gas-holders. Positive charges are more rapidly discharged by it than negative; the negative electrons move more rapidly past with their charges than positive ones do. Removal of CO_2 and H_2O vapour seems to remove a large proportion of the negative, not of the positive electrons. On storing the air there is at first a rapid rise in the dispersive power, then a steady slow fall-off. The electrons appear to be few, and even after removing all electrons by an electric field, the air still had a powerful ionising activity, which points to the presence of a radio-active emanation, electrically neutral. This renders active the walls of the glass bell, &c. The activity of this emanation is reduced but not destroyed by heating the air to a red heat. This air will render ordinary air, at rest, also active in the course of some time. A. D.

REFERENCES.

895. *Refractive Indices Measured by Talbot's Fringes.* **K. Tsuruta.** (Phys. Rev. 15. pp. 380–382, Dec., 1902.)—The Talbot fringes obtained from a hand spectroscope with direct vision, with the addition of a cover-glass plate fixed between the prisms and the Ramsden eyepiece, are employed in determining refractive indices, the above apparatus being used in conjunction with a Pulfrich total reflectometer. The cover-glass is cut with a diamond and fixed so as to cover half the field. G. E. A.

896. *Technical Photo-microscopy of Metals.* **M. A. Richards.** (Metallographist, 6. pp. 71–80, Jan., 1903. From the Journ. of Applied Microscopy, Aug., 1902.)—Description of the process of polishing, etching, mounting, and photographing specimens of iron and steel, and recording the results, as practised by steel companies. A. D.

897. *Actinometer.* **H. v. Schrötter.** (Deutsch. Phys. Gesell., Verh. 4. 13. p. 296, Sept. 25, 1902. Paper read before the 74 Naturforscherversammlung at Carlsbad.)—Actinometer for use in balloons or on glaciers, with direct comparison of the overlight and the underlight. Details promised later. A. D.

898. *The Infra-red Spectrum of Iron.* **H. Lehmann.** (Ann. d. Physik, 9. 5. pp. 1330–1338, Dec., 1902.)—The author has photographed the infra-red spectrum of iron between the limits $\lambda = 8700$ and $\lambda = 6810$; the method has been previously described [see Abstract No. 1880 (1901)]. About 60 lines were measured with a mean probable error of about 0·04 tenth metre, and the wave-lengths are given in the paper. E. C. C. B.

HEAT.

899. *Expansion of Gases under Constant Pressure.* **T. W. Richards** and **K. L. Mark.** (Amer. Acad., Proc. 38. No. 14. pp. 417–428, Dec., 1902.)—Experiments by a new apparatus upon hydrogen, nitrogen and carbon dioxide are given. The desirability of new determinations is pointed out, and the apparatus now used has the following advantages: The gas is all at a known temperature, pressure is measured to one-hundredth of a mm. of mercury, a small temperature interval is used, and the pressure observations are always made under similar conditions. An accuracy of 1 in 3,600 is attained. For hydrogen the coefficient is found to be 0·003659, for nitrogen (impure) 0·003660, for carbon dioxide 0·003727. For maintaining constant temperatures sodic sulphate is here for the first time used on a large scale.
J. W. P.

900. *Thermic Properties of Solids and Liquids.* **S. Lussana.** (N. Cimento, 4. pp. 371–389, Dec., 1902.)—By dilatometer methods, the fusing point of pure phosphorus is $T = 44\cdot24 + 0{\cdot}0298p - 0{\cdot}000000{,}66p^2$ where p is the pressure in kgr. per cm.^{2}; the volume of fused phosphorus at temperature t is $1 + 0{\cdot}000532{,}82(t - 44{\cdot}27)$, that of superfused phosphorus is $1 + 0{\cdot}000515168 (t - 44{\cdot}27)$, and that of solid phosphorus is $1 + 0{\cdot}000390596t$. Naphthalene (alpha) fuses at 94·4° at atmospheric pressure, the fusing point rising 0·0225° per atmosphere pressure.
A. D.

901. *Transition Temperature of Sodic Sulphate.* **T. W. Richards** and **R. C. Wells.** (Amer. Acad., Proc. 38. No. 15. pp. 431–440, Dec., 1902.)—This paper gives a further determination of the transition point and verifies closely those given in Amer. Jour. Sc. (4), 6, 201. The exact point is on the International Hydrogen Scale 32·383 ± 0·001. The determinations were made by means of four thermometers standardised by the Bureau International des Poids et Mesures. A full description and drawing of the apparatus are given. The sodic sulphate is placed in a large test tube in a Beckman freezing-point apparatus. This is surrounded by an air jacket. The outside bath is maintained about half a degree above the transition temperature by a small platinum resistance coil in the water. The determinations made from various samples of the salt and by the different thermometers are in close agreement. The transition point is recommended as a "fixed point" for thermometry on various grounds.
J. W. P.

902. *Application of the Kinetic Theory to Diatomic Gases.* **W. Walker.** (Roy. Soc., Proc. 68. pp. 77–78, March 25, 1901, and 69. pp. 394–398, March 7, 1902. Extended Abstract.)—A molecule in this paper is supposed to consist of two atoms of equal or unequal masses, with equal and opposite electrical charges. They are of three kinds, namely, A, in which the two atoms revolve round each other in continuous contact; B, in which they revolve round each other in elliptic orbits of finite dimensions; C, in which the orbits are hyperbolic—so that practically C consists of two atoms generally free, but temporarily united while within range of each other's attraction. The exact distinction between A and B is not defined. Molecules having this nature, the writer assumes them to be in motion with velocities distributed according to the Maxwell-Boltzmann law. That, however, seems to be unintelligible as applied to C, unless the atom is substituted for the molecule. He assumes that the number of each class will be on average constant, however individual molecules may undergo dissociation, or two atoms unite to form a more or less permanent molecule (A or B). The molecules, he says, will be mainly of class A owing to the greater energy, or less potential energy. The assumption that some molecules (C) are always dissociated agrees with experiment. As pressure diminishes the numbers of B and C together diminish, but the proportion of C to B increases. This accounts for the increased ease with which electrical discharge takes place under reduced pressure. The author next considers the magnetic effect due to the free atoms. He shows that the molecules contribute positive magnetic susceptibility agreeing with Quincke's experiments. The dielectric constant is found to be $K = 1 + kp/\theta^2$, where θ is the absolute temperature and k a constant of the gas. The result usually given is $K = 1 + kp/\theta$; the difference is explained by the analysis. In dealing with optical effects the writer considers first the free atoms and their effect on light waves. The free atoms accelerate the rate of propagation by an amount proportional to the square of the wave-length; with respect to the molecules the distribution law has in presence of waves to be modified, owing to the molecules assuming special orientations. The coefficient of rotation of the plane of polarisation in a magnetic field is obtained, and is found to vanish if the positive and negative atoms have equal masses. The angular velocity of rotation of mean square $(\overline{\omega})$ must, he says, correspond to a frequency beyond the violet of the spectrum. Hence spectral lines cannot be explained by the molecules of this theory. The writer considers them to be due to multiple molecules—which also have important bearing on the ratio of the specific heats. S. H. B.

903. *Internal Pressure, Internal Friction, Dimensions, and Mean Free Path of Molecules of Liquids.* **G. Jäger.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 697–706, May and June, 1902.)—In a former paper [see Abstract No. 444 (1903)] the writer proved on certain assumptions (which were of the essence of the theory) that Maxwell's law of distribution of velocities holds for an ideal liquid, as well as for its ideal vapour. In the present paper P denotes the internal, p the external pressure, T the temperature, Δ a small increment of T, and p is assumed small compared with P. This gives—

$$P/P + p = T/T + \Delta \quad \ldots\ldots\ldots\ldots (1)$$

Again if p be neglected v and v' are the volumes corresponding to T and $T + \Delta$, whence $v' = v(1 + a\Delta)$, a being the coefficient of expansion. Then applying an external pressure p, he obtains $v = v'(1 - kp)$, k being the compression coefficient. From these three equations he deduces $P = aT/k$ (4). He now assumes that Maxwell's law holds not only for an ideal, but also for an actual liquid. And applying the method of the former paper with its assumptions, he obtains $P = pe^{rJ/RT}$ (7), in which the symbols r, J, R have the same meaning as in the former paper. The question arises now whether (4) and (7) are consistent when numerically calculated. Now (7) is formed on the assumption that the molecules of the vapour have the same constitution as those of the liquid. For mercury this is the case, but not for water and certain other liquids. Reference is here made to the researches of Amagat, Colladon, and Sturm. In the next section the writer considers the internal friction of liquids, using the results of a former article [see Abstract No. 75 (1900)]. The method consists in the substitution in the formula for gases, instead of n the number of molecules in unit volume, of the much larger number ν determined in that article. From the result it is possible to obtain experimentally the coefficient of friction, and the internal pressure, and from these to determine the dimensions of the molecules of a liquid. This is done with the result σ the diameter $= 40 \times 10^{-9}$ cm. In the last section he finds a numerical value for the mean free path λ, namely, $\lambda = 6 \cdot 10^{-9}$ cm. S. H. B.

REFERENCES.

904. *New Thermostats.* **F. Grützmacher.** (Zeitschr. Instrumentenk., Beib. 19. pp. 184–187, Oct. 1; 20. pp. 193–196, Oct. 15; and 21. pp. 201–203, Nov. 1, 1902.) —Improved thermostats are here described (1) for ordinary water-baths, (2) for boiling liquids, (3) for boiling water specially, (4) for freezing mixtures, (5) for liquid CO_2. R. E. B.

905. *Variability with Density of Quantity b of State Equation.* **J. D. van der Waals, Jr.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 640–650, Feb. 28, 1903.)—It has been shown that the influence of the extension of a molecule on the form of the state equation, in the case of perfectly hard and elastic spherical molecules, is, in a first approximation, adequately accounted for by deducting from the volume V occupied by the gas four times the volume of the molecules. The author here discusses this first correction term, which by his father (Van der Waals, Versl., &c., V., Oct., 1896) is found to be equal to $17b_{\infty}^{2}/32V$. A. G.

906. *Papers on Low-Temperature Research.* **J. S. Shearer.** (Phys. Rev. 15. pp. 243–254, Oct., 1902.)—The author gives a very complete bibliography beginning with the year 1890. G. W. DE T.

907. *Liquefaction of Air and Hydrogen.* **K. Olszewski.** (Acad. Sci. Cracovie, Bull. 10. pp. 619–633, Dec., 1902.)—A description is given of new and simplified apparatus for prompt production of liquefied air or hydrogen, both in large quantities and in small (100 c.c.) for lecture demonstrations. In the hydrogen apparatus the spontaneous evaporation of liquefied air is applied, but the quantity used is very small (only 3 litres for 200 to 300 c.c. liquefied hydrogen). A. D.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

908. *Field of Moving Electrons.* **E. Riecke.** (Archives des Sciences, 14. pp. 609–616, Dec., 1902. Paper read before the Société helvétique des Sciences naturelles (Phys. Section), Geneva, Sept. 9, 1902.)—Investigation of the electrostatic potential. The equipotential surfaces are flattened ellipsoids of revolution, whose axes are parallel to the direction of displacement of the electron. The values of the potentials at points along the axes are the same as those which would be due to an electric particle not in motion. If the velocity of displacement of the charge be greater than that of light, the equipotential surfaces are hyperboloids of revolution contained within a cone which is asymptotal to all these hyperboloid surfaces. A. D.

909. *Electric Convection.* **V. Crémieu.** (Journ. de Physique, 1. pp. 753–771, Dec., 1902.)—The question of the direct magnetic effect, and that of the magnetic-inductive effect of electric convection, are far from being cleared up. The author gives a *résumé* of the experimental work done on this subject, the aggregative result of which is very inconclusive, even where positive results have been recorded. The conditions which must be fulfilled are, that the charge must with certainty be carried by the moving conductor; that this charge alone must act upon the apparatus intended to detect magnetic effects attributed to the electric convection; and that, during the transport of the charge, this charge must not lose more than a very small fraction of its amount. When subjected to criticism, it is found that none of the forms of apparatus used have met these conditions, perhaps largely because of secondary phenomena, some of which point towards the existence of nodes of electric oscillation, which are themselves due to variations in the distribution of the charges; and the condition of the dielectric which supports the charged moving conductor is also subject to variations. All these produce disturbing effects, even inside a closed electric screen. There are also anomalies in the distribution of charge borne by insulated conductors on solid dielectrics; and a fresh series of experiments in which these causes of error are kept in view has again led to varying and inconclusive results. There is no clear evidence for any direct magnetic effect of electric convection, but there is much room for investigation of the secondary effects referred to. A. D.

910. *Magnetic Action of Rotating Electrified Sphere.* **A. Szarvassi.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 1053–1065, July, 1902.)—In this article Hertz's vector equations ("Electrodynamics of Bodies in Motion") are taken as fundamental, with the usual impossible-to-be-written symbols for electric force, magnetic force, magnetic induction, &c., and 1/A the velocity of light, and *u* the velocity of the moving body. This velocity *u* Hertz assumes to be also that of the medium. In the present article there is assumed a field symmetrical about the axis of rotation. The writer shows that, on the last assumption of Hertz that *u* is the velocity of the medium, there can be no magnetic action, the normal component of the electric force being not zero when the moving body has a charge, and this leads to results inconsistent with Hertz's equations. Hertz's limiting conditions are inconsistent with his equations of the field. To avoid the difficulty we have only to drop the assumption that the body moves with the medium. And on this new hypothesis the author works out the magnetic force due to a moving sphere with an electric charge. Comparing his result with those obtained by Bezold and Bauer for the earth's magnetism, he finds they agree on the assumption that the earth's charge is negative, and of the order 10^{13} coulombs. So great a magnitude, the author says, is improbable. S. H. B.

911. *Electrostatic Analogy to Diamagnetism.* **L. Puccianti.** (N. Cimento, 4. pp. 408–410, Dec., 1902.)—Just as a magnet attracts a body whose magnetic inductivity is greater and repels one whose magnetic inductivity is less than that of the medium, so does a charged body attract a body whose dielectric constant is greater and repel one whose dielectric constant is less than that of the medium. This last is shown by a charged metallic ball repelling bubbles of air in vaseline oil. A. D.

912. *Electrification in Bubbling Air through Water.* **R. Fischer.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 1013–1037, July, 1902. From the Phys. Chem. Institut of the K. K. Univ., Vienna.)—The results of Kelvin, Maclean, and Galt all support the conclusion that the air-bubbles become negatively, and the water positively charged. The smaller the bubbles, the greater the charges developed with a given quantity of air. Tubes which direct the air-stream downwards give the greatest charges. Forcing the stream of air increases the electrical charges more rapidly than it does the quantity of air passed. The charge is enhanced by lengthening the travel of the bubbles through the water, at first more rapidly, until a certain height has to be traversed; beyond this the increment is small; the expansion of the bubble as it ascends seems to aid this result. Higher temperatures favour higher electrifications. The theory cannot be developed until the influence of all variations in the experiment has been studied. A. D.

913. *Electrification in Bubbling Air through Water.* **E. Alessandrini.** (N. Cimento, 4. pp. 389–402, Dec., 1902.)—Electrification by bubbling air through water follows the same laws as that by spraying liquid jets: the air becomes negative, the water positive. The potential assumed by the water tends to a limit which is the same whether reached by means of rises or falls in the potential of the water, but depends on the quality and quantity of the substances dissolved in the water, the slightest trace of impurity greatly reducing the potential, which, with pure distilled water, may reach hundreds and probably thousands of volts. The quantity of air bubbled through and the quantity of water have no influence except upon the time taken to reach the ultimate value of the potential. In sea-water the electrification is extremely feeble. Some substances, such as colouring matters in solution in the water, even affect the sign of the resultant electrification. There is no electrification unless there is a mechanical fracture of bubbles of air or of a jet of liquid; air driven through wetted wool, &c., does not become at all electrified. A. D.

914. *Electricity Dispersion in the Free Atmosphere.* **J. Elster** and **H. Geitel.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 946–981, July, 1902.)—This is a *résumé*, from the ionic standpoint, of the authors' observations conducted since 1898 at Wolfenbüttel, and periodically during journeys to the

Alps, Italy, Algiers, Denmark, Norway, Spitzbergen, &c. The authors describe their modification of Linss' instrument (of 1887) for measuring the dispersion, refer to the more portable form they afterwards adopted, and regret the necessity for using a cylindrical guard. The dispersion is not the same in an enclosed space as in the open air, and some radio-active influence seems to be at work; for instruments that come fresh from the workshop or have been kept packed up for some time give smaller values than instruments used for days, and working in caves renders the instruments more sensitive. At Wolfenbüttel the ratio of q (dispersion coefficient for negative to coefficient for positive charges) is 1·06, as in general (except on mountains and on sea shores); only near the waterfalls of Hallarmö (Norway) q was found less than 1. The rapidity of the negative discharge indicates a predomination of positive ions in the air. There is no distinct temperature influence in perfectly clear air; in dusty air the dispersion seems to increase with higher temperatures, provided the temperatures are not extreme. Humidity has the opposite effect that is popularly assumed; the dispersion is independent of the absolute humidity, but decreases with increasing saturation; this is confirmed by direct experiments, observations on Spitzbergen [see Abstract No. 1706 (1902)], and by Pochettino, and would show that the ions serve as condensation nuclei and are then impeded in their movements. Winds with descending air-currents (foehn, bora) bring very high dispersion, possibly with the strongly ionised air from higher strata. Everything impairing the transparency of the air—mist, smoke, dust, haze—diminishes the dispersion; there may be a static attraction between the ions and the particles. Moderate winds favour the dispersion, which has its daily maximum about noon, and its annual maximum in April, and minimum in January. On mountain-tops (Säntis, Gorner Grat, 3,140 m., &c.) the q becomes abnormally high, up to 15 on the Gorner Grat; at Spitzbergen also values up to 2·7 were observed. On mountains this may be due to a polar influence of the earth field; but that would not apply to Spitzbergen, where an excess of positive ions may be assumed as in the air of cellars. The q become greater—*i.e.*, the prevalence of the negative discharge more marked—when the cylindrical guard is dispensed with. Within large towns the dispersion coefficients are reduced to ½ or ⅓ of their values in the purer country air. H. B.

DISCHARGE AND OSCILLATIONS.

915. *Emission of Negative Particles from Hot Bodies.* **J. J. Thomson.** (Phil. Mag. 4. pp. 253–262, Aug., 1902.)—After referring to Elster & Geitel's discovery of the emission of negative electricity from a hot wire in vacuo (Wied. Ann. 37. p. 315), and to his own demonstration in 1899, that the carriers of this were identical with those observed in the kathode rays, the author points out that Richardson's experiments [see Abstract No. 1091 (1902)] show an emission from incandescent carbon equivalent to a current of an ampere per sq. cm. of carbon surface. He then considers some of the effects which must arise from so great an emission. The negative particles will, according to the electromagnetic theory of light, be set in motion by light waves, and hence scatter the light. He then calculates the energy of the light scattered in this manner, and shows that it will be polarised as if reflected from small particles, and if the light is homogeneous the spectrum will widen into a band. He suggests that some of the observed phenomena of the solar corona may be due to this cause. He shows that the sun would appear to repel the corpuscles, because the effect of an electromagnetic wave will be to propel them in the direction of the wave. The velocity so communicated would be inconsiderable for the waves of sunlight, but might become comparable with the velocity of light if the sun emitted Hertzian waves of long period. If a comet emitted such corpuscles, they would be repelled by Hertzian waves from the sun, and appear as a luminous tail behind the comet. The emission of these corpuscles from a hot body involves the existence of streams of corpuscles within the body—streams of kathode rays in fact. Their collision with the molecules would therefore produce electromagnetic pulses, but on account of the comparatively low velocity, these would be much "softer" than the Röntgen rays produced in a vacuum tube. A succession of sufficiently broad pulses would produce a continuous spectrum of the kind given by a hot body, and this part of the radiation would have the characteristic property of increasing rapidly with the temperature. G. W. de T.

916. *Electrical Discharge from Hot Carbon.* **C. D. Child.** (Phys. Rev. 15. pp. 345–354, Dec., 1902.)—When a carbon pencil is heated the positive discharge occurs first whether the carbon is heated in air at normal pressures, in a vacuum, or in hydrogen. In air it requires only a slight increase in temperature to produce the negative discharge. At higher temperatures the negative discharge is the greater. Both positive and negative pass through maxima as the temperature is raised. In an enclosed tube the discharge is much smaller than in open air. In a vacuum the negative discharge becomes many times greater than the positive at higher temperatures, and the rates of discharge do not here pass through maxima. In general the discharge from hot carbon behaves like that from hot platinum. The velocity of the ions is diminished by reason of the presence of particles driven off from the carbon. It is probable that the smaller velocity of the negative ions is due to their being loaded more than the positive by these particles.

W. C. H.

917. *Oscillatory Discharge of Condenser with High Resistance in Circuit.* **H. Tallqvist.** (Ann. d. Physik, 9. 5. pp. 1083–1099, Dec., 1902.)—When account is taken of the conductivity of the insulating layers of the induction coil and of the dielectric of the condenser, theoretical values are obtained for the logarithmic decrement of the oscillations which agree very closely with experiment even with high values for the resistance in the circuit; and further, theory and experiment correspond very closely in relation to the transition from oscillatory to a periodic discharge. A. D.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

918. *Definitions Relating to Conducting Systems.* **F. Breisig.** (Elektrotechn. Zeitschr. 23. pp. 1137–1139; Discussion, pp. 1139–1140, Dec. 25, 1902. Communicated by the Kais. Telegraphen-Versuchsamt, and read before the Elektrotechn. Verein, Oct. 28, 1902.)—The author calls attention to certain loose expressions representing, or purporting to represent, the various quantities involved in calculations of the capacity and self-induction of conductors, particularly in relation to cables containing two or more conductors. He attempts to bring the various cases into conformity by referring them to the ideal single conductor far removed from other conductors. He suggests the following definitions: The quantities as denominated should refer to the properties of an individual conductor, and not to the system as a whole. By the term "resistance" is thus to be understood the resistance of some particular component conductor. The "self-induction" is to be understood to mean the number of lines of force which this observed conductor cuts when unit current begins or ceases in it, it being premised that the appropriate currents are at the same time acting in the other components of the system. The "capacity" is to be referred in like manner to a single component conductor, and is to be measured by the ratio of the quantity of electricity associated with that component at a given potential, to that potential, when the other components are at their appropriate potentials. By the term "potential" is always to be understood the potential difference referred to zero. R. A.

919. *Conductivity and Polarisation in Dielectrics.* **E. R. v. Schweidler.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 579–592, May and June, 1902. From the Phys. Chem. Institut of the K. K. Univ., Vienna.)—In different kinds of glass, the resistance, when a stationary value of the current through the glass has been reached, is independent of the electromotive force; at higher temperatures the quantity of electricity passed by discharge of the polarisation of the dielectric is increased, but not in proportion to the conductivity, so that the period of polarisation of the dielectric remains unaltered. In different badly-conducting liquids and in different kinds of paper the polarisation is unimportant in comparison with the variations in the resistance that are caused by the passage of the current. The stationary final values of the current are not proportional to the electromotive force; and the departures from proportionality are in one sense for liquids and in the other for paper. Paper as a dielectric offers some peculiarities in the time-relation of the current strength after commutation of the current. A. D.

920. *Anisotropic Dielectrics.* **A. Lampa.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 982–995, July, 1902. From the 1st Physik. Inst. of the K. K. Univ., Vienna.)—A theory of anisotropic dielectrics is developed on the assumption of unequal densities, and corresponding distribution of the conducting particles, in three axial directions. The theory leads to a value 2·747 for the dielectric constant of rubber at right angles to the direction of stretching, while the observed value was 2·727. A. D.

921. *A Simple Method for the Determination of Dielectric Constants.* **J. Billitzer.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 814–822, May and June, 1902. From the Phys. Chem. Institut of the K. K. Univ., Vienna.)—The substance whose dielectric constant D_x is required, is suspended in a liquid of known dielectric constant D_1. From the induction effect produced by two charged parallel platinum wires suspended vertically behind the substance in the liquid, the author determined the nature and amount of deflection, the sign of the deflection being positive, zero or negative, according as $D_x \gtreqless D_1$. If D_x is greater than D_1 the suspended body is attracted towards the platinum wires; by alteration of the constituents of the liquid so as to vary the value of D_x, the values of D_1 are obtained by means of interpolation. The vertical platinum wires are connected with an induction apparatus having a motor mercury interrupter, the alternating current being used to avoid polarisation effects. The substance under test is, if possible,

drawn out to a fine thread and fixed by a drop of collodion to a short quartz suspension fibre, the movement of the thread being observed with a microscope having a micrometer eyepiece. To obtain a wide variation in the dielectric constant, the liquid chosen is a mixture of acetone and hexane, giving a range from 1·85 to 20·44. A mixture of ethyl ether and benzol is also recommended. The following results with glass show the method of calculation :—

Composition of Liquid.		Dielectric Constant of Liquid.[1]	Deflection of Glass Filament.
Hexane 1	Acetone 0	1·85	−10
„ 9	„ 1	3·46	− 2·5
„ 6	„ 1	4·2	+ 2
„ 4	„ 1	4·81	+ 5
„ 3	„ 1	5·9	+ 10
„ 0	„ 1	20·44	+ 22 to + 29

[1] These constants are measured by Nernst's method.

On plotting the results on a curve the value of D_1 for glass is 4·0. In the case of sulphur the constant is 3·8 ; sealing wax, 4·5 ; silk, 1·6. The method is suitable for obtaining the dielectric constants of small quantities of substances to a fair degree of accuracy ; by using fibres with known constants the value of D_x for different liquids may also be determined. E. S. A. R.

922. *Electrostriction of Glass.* **A. Wüllner** and **M. Wien.** (Ann. d. Physik, 9. 5. pp. 1217–1260, Dec., 1902.)—The increase in the internal volume of spherical and cylindrical condensers, due to electrostriction of the glass, is in general smaller than the coefficients of elasticity (as determined by acoustic experiments or by means of compression) would indicate. The difference is greatest in flint glass, least in Thuringian glass. The after-effect after discharge, observed by Quincke and Cantone, which slowly passes off and lasts the longer, the longer the preceding charge had continued, is due to the expansion of the glass through Joule heating. The coefficient of elasticity of glass as determined by compression is generally a little less than that found by acoustic methods ; the difference being greatest in flint and least in Thuringian glass. A. D.

923. *Carbon Resistances.* **A. C. Longden.** (Phys. Rev. 15. pp. 355–365, Dec., 1902.)—The author describes a method of making carbon resistances of clay and graphite moistened with sugar solution ; the moist clay thus formed is pressed into cylindrical sticks about 5 mm. in diameter, baked in an oven and then carbonised by keeping them at red heat about eight hours in a covered crucible packed with graphite. The graphite in the mixture may be omitted, in which case the sticks are of higher resistance. The best form of contact for the ends is to wrap several turns of fine copper wire round them, and make this wire the kathode in a copper-depositing cell. The copper is at first deposited only on the wire, but in a short time it creeps over the surface of the clay-carbon stick and soon forms a perfect coating over as much surface as is immersed in the bath. A better form of carbon resistance is made by silvering the ends of a glass strip by chemical means, and then covering the glass slip with smoke, preferably from burning camphor ; these smoke films may be hardened by exposure to alcohol vapour, after which they may be covered with shellac or rubber varnish or coated with paraffin wax. All carbon resistances increase in resistance with age, but the smoke-film ones considerably less than the clay-carbon cylinder ones, and the former become practically constant after about a year's time. E. C. R.

924. *Improved Form of Capillary Electrometer.* **G. J. Burch.** (Roy. Soc., Proc. 71. pp. 102–105, Dec. 27, 1902.)—The capillary electrometer must be simple, easy to adjust and clean, and not liable to be broken when used with reasonable care. Above all, it must be suitable for use with objectives of short focus and wide-angle condensers. The author has devised many different forms of electrometer intended to satisfy these conditions, and in the present paper he describes the most recent improvements. In the type hitherto favoured by the author the capillary was placed within a piece of thick-walled burette tubing of 1 mm. bore, half ground away so as to form a trough of semi-circular section, and with a cover-glass as front [see Abstract No. 102 (1903)]. This type gave excellent results, but there was a difficulty in adjusting the capillary. The author has therefore changed his plan for one in which the safety of the capillary depends not on the rigidity of the supports by which the trough is fixed, but on their perfect flexibility, and on the use of a trough so light that its entire weight might even be borne by the capillary. The trough is made from two flat pieces of mica placed one on top of the other. One of them has a long narrow slot cut down the centre for about three-fourths of its length; the other has the same length as this slot and has a V cut out at the part coinciding with the top of the slot, and a semicircle of diameter equal to the width of the slot, cut out at the part coinciding with the bottom of the slot. These two pieces of mica, thus forming a trough, are fastened together by loops of Pt wire at the four corners, and the whole is suspended by long-link chains of Pt wire, so that the capillary attached to the pressure apparatus rests against the centre of the trough. For adjustment, the apparatus can be tilted back at each operation so that it is free of the capillary. When the inside of the trough has been wetted, the apparatus is tilted forward until the trough touches the capillary and sticks to it. A piece of thin cover-glass, slightly wider than the trough, is then wetted on one side with acid and placed carefully against the trough, holding it firmly against the capillary, the lower edge of the glass resting against the Pt loops with which the trough is fastened together. The wide end of the U-tube into which the trough dips is then brought up underneath until the lower edge of the glass just dips into the acid, when the tube is clamped. Finally, the trough is gently shaken until the acid rises in it to the required height and all bubbles are expelled. These electrometers give perfect definition. The capillary touches the cover-glass throughout its length, so that any dry objective can be used. W. C. H.

ALTERNATING CURRENTS AND MAGNETISM.

925. *Action of a Magnetic Field on the Anode Column.* **H. Pellat.** (Comptes Rendus, 135. pp. 1321–1324, Dec. 29, 1902.)—The general method and the results of the author's previous experiments have been described fully [see Abstract No. 1872 (1902)]. In the present paper investigation is made in the vacuum tube on pure hydrogen and pure oxygen, and on a mixture of the two gases. The resistance to the anode- or cathode-stream across the lines of force the author calls magnetofriction; and he shows that

magnetofriction is much less pronounced in oxygen than in hydrogen for the same pressures and fields. The mixture behaves like a gas having properties intermediate between those of the components. P. E. S.

926. *Minimum Impedance of an Inductive Coil.* **Chalkevitch.** (Assoc. Ing. Él. Liége, Bull. 3. pp. 20–23, Jan., 1903.)—It is known that, although the effective p.d. applied across the terminals of an ironless inductive coil is kept constant, yet the magnitude of the current in it varies with the shape of the current wave. The author applies the calculus of variations to find out whether the current will be an absolute maximum for any particular shape of wave. In symbols, the problem is to find the maximum value of $\int_0^T i^2 dt$ when i satisfies the equation,

$$V^2T = r^2\int_0^T i^2 dt + L^2\int_0^T \left(\frac{di}{dt}\right)^2 dt.$$

Equating the first variation to zero we find that the extreme values of i are given by—

$$(\lambda + r^2)i - L^2\frac{d^2i}{dt^2} = 0$$

where λ is an undetermined multiplier. This equation admits of three solutions, but the only periodic one is $i = I\sin(\omega t - \alpha)$. The calculation of the second variation is extremely complicated, and so the author proves by general reasoning that the above solution makes the effective current and therefore also the power expended a maximum. A. R.

927. *Hall Effect and the Velocities of Ions of Salt Vapours.* **G. Moreau.** (Comptes Rendus, 135. pp. 1326–1328, Dec. 29, 1902.)—Marx [see Abstract No. 2211 (1900)] has measured the coefficient of rotation, R, due to the Hall effect for flames charged with KCl at different concentrations, and with NaCl. Interpreting R by the ionic theory, the author developes the approximate formula—

$$R = K_2 - K_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots(1),$$

K_2 and K_1 being the mobilities of the positive and negative ions. Comparing the results of Marx with the values obtained by himself for K_1 and K_2, the author finds that this formula is sufficiently close to the truth when we make proper allowance for the differences of temperature at which the mobilities and R were observed, and that it furnishes a kinematic interpretation of the Hall effect, which experiment verifies. Marx has also developed the formula $R\sqrt{M} =$ constant, where M is the molecular weight of the metal, and from this formula and (1) we get, as K_2 is much smaller than K_1—

$$K_1\sqrt{M} = \text{const.} \quad \ldots\ldots\ldots\ldots\ldots\ldots(2),$$

which also confirms what experiment has shown, that the negative ion only depends on the metal of the vapour. The author considers it to consist of a nucleus, formed by the dissociation of the metallic atom, which groups around it other non-ionised atoms increasing in number with the concentration. The positive ion will then be the remainder of the atom along with molecules of the medium burning in the flame. This would explain the preponderating influence of the metal in the conductivity of salt vapours, which has been observed by Arrhenius. W. C. H.

928. *Change of Length and of Thermoelectric Power by Magnetisation.* **E. Rhoads.** (Phys. Rev. 15. pp. 321–326, Dec., 1902.)—A thermopile is constructed of wires in the following complete cycle: iron, alloy, copper, alloy. A great many such cycles being placed in series, alternate ends are heated and cooled by steam and cold-water jackets. The alloy mentioned is of bismuth and antimony and serves to neutralise the thermoelectric effect of the iron and copper junctions so as to give no thermoelectric force on the whole when no magnetic field acts on the system. On placing the whole in a solenoid and passing current, thermoelectric force is produced—which, as the field due to the current increases, first increases to a maximum (M_1), and then diminishes. If the last strong field be reduced gradually, the thermoelectric force increases, attains a maximum (M_2) greater than before, and then, when the field is nil, still remains large. By reversing the field, a complete cycle of a hysteresis nature is obtained. This curve of field and thermoelectric force the author gives, and he shows that it is similar to the curve between field and change of length for the same iron as that used in the experiments above. But the latter curve is not the usual experimental curve; it is obtained by applying the correction for the Maxwell stress $B^2/4\pi$ to the curve. Testing nickel instead of iron the author observes a similar likeness between the two relations. Strain causes a change in thermoelectric power, and so it may be that the strain set up by the magnetisation may produce the changes in thermoelectric force and explain the results.

P. E. S.

929. *International Magnetic Observations during the Total Solar Eclipse of May* 18, 1901, *and Previous Eclipses.* **L. A. Bauer.** (Terrestrial Magnetism, 7. pp. 155–192, Dec., 1902.)—During the total solar eclipse of May 28, 1900, a slight magnetic effect, directly associated apparently with the passage of the shadow cone, was observed within and close to the belt of totality in the United States. The effect was not of the nature of a magnetic disturbance; it was not cosmical, because not simultaneous for different regions, but its cause seemed to be outside the earth's crust. International co-operation was hence agreed upon for the eclipse of May 17–18, 1901. The track of the shadow cone extended in a curved belt from Madagascar across Mauritius, the Indian Ocean, Sumatra, and Borneo to New Guinea. That it was in the southern magnetic hemisphere was fortunate, the previous eclipse having been in the northern hemisphere; but there were only three observatories available—on Mauritius, and at Karang Sago and Sawah Loento, on Sumatra; further at Batavia, 350 miles south of the belt, and Manila, 1,000 miles to the north of it. Check observations were conducted at twenty-eight stations all over the globe; the instructions which the author issued for this purpose in the United States have been mentioned in Abstract No. 1724 (1902). The results tabulated in the paper show that during the interval of the observations, viz., May 17, 1902, 14 h. to 21 h. (Greenwich mean astronomical time), there was no general magnetic disturbance. In the belt of totality a marked eclipse effect was noticed, especially in the generally most susceptible horizontal intensity, which decreased on Mauritius and Sumatra, and at Batavia, and increased at Manila, which is in the opposite magnetic hemisphere. Vector diagrams are reproduced. The paper further refers to the previous eclipses of December 22, 1870 (observed in Sicily), December 12, 1871 (Batavia), May 28, 1900 (United States); these records are grouped according to local time. It results that the eclipse magnetic variation is opposite in the two magnetic hemispheres, and opposite for the morning and the afternoon

hours, and therefore in nature analogous to the diurnal variation, differing only in degree. The probable cause of the eclipse effect is the cutting off by the moon of certain rays (kathode rays, *e.g.*) in the upper atmosphere. As the earth itself always eclipses one of its sides, we should have a similar diurnal effect. If the magnitude of the effect on the range of declination variation, for instance, be proportional to the amount of sunlight a body is able to cut off, then—the distance of the earth and moon from the sun being practically equal—the earth effect should be to the moon effect as the squares of their diameter, *i.e.*, as $3{\cdot}67^2 : 1$ or as 13·5 : 1. The diurnal range at Rocky Mount (North Carolina) was 10·8′ (eclipse of 1900), the eclipse effect should hence be 0·8′; the observed value was 0·9′. For Mauritius and Batavia and the 1901 eclipse the computed (observed values) are 0·5 (0·6) and 0·4 (0·7)′. The author further examines whether the seasonal change in the diurnal range of the magnetic declination is related to the varying diurnal intensity of solar radiations. Calculations of the ratio of mean diurnal range of magnetic declination in the summer months to the means of the winter months agree with observations for three American stations and for Mauritius, but not for Potsdam; these latter observations and calculations concern different periods. H. B.

930. *Magnetic Observations on Land by the Austrian Navy between* 1896 *and* 1901. (Terrestrial Magnetism., 7. pp. 196–198, Dec., 1902. Abstract.)—The Austrian ships *Albatros, Freundsberg, Saida,* and *Donau* took magnetic measurements on shore during their cruise at twenty-eight spots in the East Indies, Eastern Asia, Australia, Honolulu, Africa, and South America. The results are tabulated in this paper; full particulars in Veröffentlichungen des Hydrographischen Amtes, Pola; Gruppe IV., Erdmagnetische Reise-Beobachtungen. III. Heft. Pola, 1902, 52 pp. H. B.

REFERENCES.

931. *Dispersion of Electricity in the Free Atmosphere of Capri.* **V. Cuomo.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 6. pp. 324–353, 1902.)—Report on the continued observations, March to Sept., 1902 [see also Abstract No. 2072 (1902)]. H. B.

932. *Curve-tracing Instrument.* (Amer. Inst. Elect. Engin., Trans. 19. p. 1174, Aug. and Sept., 1902.)—Discussion at Great Barrington on paper dealt with in Abstract No. 2089 (1902).

933. *Current Distribution in a Network of Conductors.* **W. Feussner.** (Ann. d. Physik, 9. 5. pp. 1304–1329, Dec., 1902.)—The author discusses the general laws of Kirchhoff and Maxwell, and indicates the method of treatment in cases of imperfect network systems. E. S. A. R.

934. *Industrial Magnetic Measurements.* **Armagnat.** (Soc. Int. Elect., Bull. 2. pp. 714–753, Nov., 1902.)—After a brief account of the principles involved, the author discusses the long list of permeameters in the market. Then he compares the hysteresimeters of Ewing and Blondel. P. E. S.

935. *Electrolysis of Metallic Salts in the Organism.* **A. Poëy.** (Comptes Rendus, 135. pp. 874–876, Nov. 17, 1902.)—The author recalls a paper in the Comptes Rendus for 1855 in which he described how to extract metals from the system of a patient by passing a current through his body into the liquid of an acidified bath. The metal travelled with the current, traversed the skin, and was found in the acidified bath. A. D.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

936. *Formation of Oceanic Salt-Deposits. Temperature of Formation of "Hard-Salt."* **J. H. van't Hoff** and **W. Meyerhoffer.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 52. pp. 1106–1109, Dec. 11, 1902.)—The temperature at which the natural salt-beds were deposited can be determined by the presence of: (1) minerals such as langbeinite and loeweïte, which cannot be formed *below* 37° and 43° respectively; (2) minerals which cannot exist *above* a definite temperature; (3) combinations of minerals which can only exist together within definite temperature limits. An example of the last class is "hard-salt," an intimate mixture of sylvine (KCl) and kieserite ($MgSO_4, H_2O$) with common salt. At ordinary temperatures these combine to form kainite ($MgSO_4, KCl, 3H_2O$), which can exist in contact with excess of kieserite or excess of sylvine, but the latter cannot exist uncombined in contact with the same solution. The temperature at which kainite dissociates into sylvine and kieserite in a solution saturated with common salt was therefore determined, and found to be 76° by the dilatometer and 72° by the tensimeter. This, therefore, is the minimum temperature at which "hard-salt" can be formed.

T. M. L.

937. *Argon and Free Sulphur in Natural Springs.* **H. Moissan.** (Comptes Rendus, 135. pp. 1278–1283, Dec. 29, 1902.)—The author's attention was directed to these springs by their therapeutic effects. In the first, *Source Borden*, No. 1, the sulphurous water issues from longitudinal fissures in the schistous rock at a temperature of 44° C. The gas, when collected without contact with air, hardly affected the surface of mercury, and was found to contain no trace of SH_2. This seems to indicate that the sulphurous water of the Borden Spring does not contain hydrosulphate, for otherwise it would produce SH_2 by dissociation. The moment that the water of the spring comes in contact with the CO_2 of the air, SH_2 appears. The free gas collected contained no CO_2, nor were there any traces of O. It consisted of a small quantity of methane, a great quantity of nitrogen, and a little argon. A spectral analysis of the argon did not reveal the presence of helium. The Grotto Spring was found to contain sulphur in solution, while the vapour emanating from the inhalation tubes contains very small quantities of sulphuretted hydrogen, sulphurous acid, and volatilised sulphur, the latter being derived from three sources: (1) the slow combustion of sulphuretted hydrogen, (2) the reaction of a small quantity of sulphurous acid upon the sulphuretted hydrogen, and (3) vaporisation of sulphur in solution in the water. This sulphur vapour may play a part in the therapeutic action of the inhalation, either as an antiseptic or owing to the facility of its assimilation.

G. G.

938. *Action of Alkalies on Glass and on Paraffin.* **F. Jones.** (Manchester Lit. and Phil. Soc., Mem. 47. 3. pp. 1–17, Dec. 15, 1902.)—In order to test whether in Pettenkofer's method of determining carbon dioxide in air any of the alkali might be neutralised by the silica of the glass, lime, strontia, and baryta water were enclosed (1) in plain glass bottles, (2) in bottles containing 0·1 gr. silica, and (3) in bottles containing 1 gr. powdered glass. In the course of six months the lime-water had lost 13 per cent. of its alkalinity in the plain bottle, but the strontia and baryta were unaltered; in the bottles containing silica and powdered glass all the alkalies were much reduced in strength, but here again the effect was greatest in the case of the lime-water, which in the course of a few months was almost completely neutralised by the silica. Sometimes the bottles are lined with paraffin wax in order to prevent the action of the alkali on the glass; for some little time no action occurs, but ultimately the action is (at least in the case of baryta) very much greater than the action on the plain glass. In a test experiment, in which alkaline solutions were left in contact with paraffin shavings during five months, the lime-water lost 22 per cent., the strontia 30 per cent., and the baryta 99 per cent. of its alkalinity; the solution contained no organic matter, but the alkali was found to be associated with the paraffin. T. M. L.

939. *Oxidation of Alcohol and Aldehyde.* **J. Slaboszewicz.** (Zeitschr. Phys. Chem. 42. pp. 343–352, Dec. 23, 1902.)—When aldehyde is warmed with water, it undergoes autoxidation, one portion of the aldehyde being oxidised to acetic acid at the expense of another portion which is reduced to alcohol. As the author shows, the diminution of the free energy in the oxidation of aldehyde to acid is greater than in the oxidation of alcohol to aldehyde, as is also shown by measurements of the electric potential both in alkaline and acid solutions. The author also discusses the oxidation of alcohol by potassium ferricyanide in alkaline and acid solution. In acid solution, the difference of potentials for potassium ferricyanide and for alcohol is 0·091 volt; in alkaline solution, 0·956 volt, so that it is not to be wondered at that oxidation occurs instantaneously in alkaline solution. A. F.

940. *Combustion in Oxygen of Three Varieties of Carbon.* **H. Moissan.** (Comptes Rendus, 135. pp. 921-928, Dec. 1, 1902.) — Experiments upon diamond, graphite, and amorphous carbon are described. The combustion of the different varieties takes place at temperatures which increase with the degree of polymerisation of the carbon. Diamond becomes incandescent at 800–875°, graphite at 650–700°, amorphous carbon at 300–500°. Each of these vigorous reactions is preceded by a reaction slower in proportion to the distance of the temperature from the combustion point J. W. P.

941. *Transformation of Diamond into Black Carbon by Oxidation.* **Berthelot.** (Comptes Rendus, 135. pp. 1018–1020, Dec. 8, 1902.) — An account of observations in which the diamond is burnt incompletely in pure and dry oxygen is given. Graphite is formed. The question is raised whether the transformation results from the action of the high temperature alone or from an isomeric change at the moment of combination. Similar phenomena in the case of other substances are described. J. W. P.

942. *Formation of Layers in Solutions. Pseudomolecular Compounds.* **A. Sinding-Larsen.** (Ann. d. Physik, 9. 5. pp. 1186–1197, Dec., 1902.)—If in a solution of which the concentration increases from the top downwards a difference of temperature is established along a vertical strip of the containing vessel (*e.g.*, by contact with a strip of hot copper or cold, trickling water), the whole mass of liquid breaks up into a series of separate layers which are especially prominent if the difference in refractive index is sufficient to permit of total reflection. The boundaries are not horizontal, the slope, as well as the sharpness of the boundaries, being determined by the temperature-gradient and the limits between which the concentration varies. There is a continuous circulation in each layer, and the layers gradually increase in thickness and decrease in number. T. M. L.

943. *Velocity of Solution of Solid Bodies.* **L. Bruner** and **S. Tolloczko.** (Zeitschr. Anorg. Chem. 35. 1. pp. 23–41, April 30, 1903.)—In a previous paper [see *id.* 28. p. 314, also Abstract No. 405 (1901)] the authors began a methodical investigation into the factors controlling the velocity of solution of solid bodies, viz.: (1) The speed the solvent water is stirred at; (2) the volume of the solution. As, however, the arrangement then adopted did not allow of more than 400 turns per minute being obtained, they now describe two other methods, enabling the speed of stirring to be driven up to figures as high as 950 and 2,200 turns per minute respectively. The results of these experiments tend to show that the constants of the velocity of solution are practically proportional to the speed of rotations up to about 9 m. per second. The amount dissolved is proportional to the speed of the gliding water, no evidence as to the existence of a maximum velocity being found. As regards the influence of the volume of the solution, previous experiments had failed to detect any influence of this sort. In this paper, however, the constants of the velocity of solution are found to be inversely proportional to the volume, though for higher speeds of rotation some disturbing factors may impair the results. The authors finally give some theoretical deductions from their experiments, it being suggested that the velocity of solution be defined as the amount dissolved by the unit (1 sq. c.) of surface in the unit of time (1 hour), the surface being washed by a current of pure solvent of any constant velocity. A. G.

944. *Relation between Negative Pressure and Osmotic Pressure.* **G. A. Hulett.** (Zeitschr. Phys. Chem. 42. pp. 353–368, Dec. 23, 1902.)—The term "negative pressure" is used to denote the force which tends to increase the volume of a liquid without changing its temperature, and the author gives a summary of the work done since Berthelot's demonstrations in 1850. The author performed some experiments similar to those of Askenasy; a tube 2 metres long was closed at the upper end by a porous plate containing a semipermeable membrane of copper ferrocyanide, filled with de-aërated water and inverted in a mercury trough. The water evaporated from the porous plate on top, and mercury rose in the tube till a height of 1,111 mm. of Hg (347 mm. more than the barometric height) was reached before the liquid broke away from the plate; it was found that the rate of evaporation of the liquid from the porous plate diminished as the experiment proceeded, *i.e.*, the vapour pressure became less as the "negative pressure" increased. Osmotic pressure may be considered as a "negative pressure"—a pressure exerted by the dissolved substance on the solvent and tending to increase the volume of the latter. On this assumption a quantitative expression may be found for the relation between osmotic pressure considered as a negative pressure and the lowering of the vapour pressure. By considering a relevant cycle of operations, we find that $P = -V\Delta p/\psi(d-g)$, where $P =$ osmotic pressure, $d =$ weight of 1 cc. of the solution, $g =$ weight of dissolved substance in 1 cc. of solution, $\Delta p =$ lowering of vapour pressure, $\psi =$ molecular volume of water, $V =$ molecular volume of water vapour. D. H. J.

945. *Equilibrium between Urea and Ammonium Cyanate.* **J. Walker.** (Zeitschr. Phys. Chem. 42. pp. 207–208, Dec. 9, 1902.)—C. E. Fawsitt in his paper on the decomposition of urea in aqueous solution states [see Abstract No. 515 (1903)] that with rise of temperature there is displacement of the point of equilibrium, so that at the higher temperature there is a larger formation of cyanate. The author points out that this result is in accordance with his own observations, and that Fawsitt's supposition to the contrary rests on a misunderstanding. Indeed the author's experimental results may be deduced from those of Fawsitt by applying the van't Hoff equation

$$4{\cdot}6(\log_{10}K_2 - \log_{10}K_1) = q\left(\frac{1}{T_1} - \frac{1}{T_2}\right).$$

D. H. J.

946. *Electromotive Force of Alloys of Tin, Lead, and Bismuth.* **E. S. Shepherd.** (Journ. Phys. Chem. 7. pp. 15–17, Jan., 1903.)—The author has already shown that tin crystallises pure from a melt containing either lead or bismuth, while lead and bismuth form two series of solid solutions, the limiting concentration being about 10 per cent. in each of the solid phases [see also Abstract No. 676 (1903)]. These conclusions, which were based on quantitative analysis and were in accord with the freezing-point curves, the density relations, and the appearance under the microscope, have now been confirmed by measurements of the electromotive force of the bismuth-lead alloys. A. F.

947. *Glowing Electrolytic Bodies.* **E. Bose.** (Ann. d. Physik, 9. 5. pp. 1061–1069, Dec., 1902.)—The author has already shown that the conduction in the filament of a Nernst lamp is electrolytic [see Abstract No. 1887 (1902)]. He now notices that when the glowing filament is in a vacuum, there is an intense blue light surrounding it, provided the current be continuous. With alternating currents this does not appear. It was at first thought that Rayleigh's theory of the blue sky would explain the results, afterwards a theory depending on conduction through the surrounding rarefied gas; neither of these was, however, satisfactory. The following, however, is thought to be the true explanation: when the continuous current passes, electrolysis occurs, and an atmosphere of metallic vapour is formed, which conducts better than the pure gas, and it is the current passing through this which causes the light. The paper concludes with the results of some experiments on tubes having electrolytes as electrodes. In every case definite chemical separation is found. The author thinks that this supports the theory of G. C. Schmidt and others concerning the changes which take place in solids when bombarded by kathode rays. R. S. W.

REFERENCES.

948. *Theory of the Action of Halogens on Alkalis.* **F. Foerster** and **E. Müller.** (Zeitschr. Elektrochem. 8. pp. 921–926, Dec. 18, 1902. From the Elektrochem. Laboratorium der Technischen Hochschule at Dresden.)—A discussion of the action of halogens on alkalis from the point of view of the law of mass action. A. F.

949. *Aluminium as a Reducing Agent in Metallurgy.* **G. P. Scholl.** (Electrochem. Ind., Philadelphia, 1. pp. 175–178, Jan., 1903.)—This is mainly an account of the process of reducing refractory oxides by mixing them with finely-divided aluminium, and enkindling the mixture with a fuse. The thermo-chemical explanation given by Goldschmidt (Zeitsch. Anorg. Chem. 1902, 699) is also referred to at some length. W. G. M.

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER 1903.

GENERAL PHYSICS.

862. *Dimensions of Units.* **L. Gorczyński.** (Phys. Zeitschr. 4. pp. 153–156, Dec. 1, 1902.)—This is a criticism of methods of basing all dimensions upon [L], [M], and [T], with special reference to Heat in which [θ] is required and to Electrostatics and Magnetism where [K] and [μ] are needed. In the latter, however, we may eliminate [μ] by using Laplace's equation, $dF = c.i.m. \sin a . dl/r^2$, whence—

$$[\mu] = L^{-2}T^{2}K^{-1} \text{ and } [m] = L^{3/2}M^{1/2}T^{-1}\mu^{\frac{1}{2}} = L^{1/2}M^{1/2}/K^{\frac{1}{2}},$$

and we thus reach a "magneto-electric" system. But, on the whole, it appears that [K] and [μ] cannot be expressed in terms of L, M, and T. A. D.

863. *Instrument for Drawing Sine Curves.* **A. S. Mackenzie.** (Phys. Rev. 13. pp. 366–367, Dec., 1902.)—Suppose one ruler of the pair in a parallel ruler to be fixed, and one of the connecting links made of a disc with a groove in its circumference to which one end of a string is fastened, and upon which the string winds (or unwinds) as the disc turns. When the disc rotates uniformly the free end of the string moves uniformly, and can be made to move a carriage sliding on the fixed ruler, at the same time the movable ruler has the up and down component of its motion simply harmonic. On transferring these two motions to a common point the latter will move in a sine curve. The above is the principle on which this instrument is constructed; for the way it is carried out reference must be made to the original paper.
E. C. R.

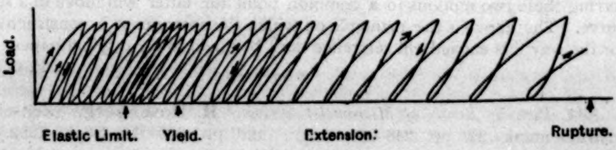
864. *Periodic Errors of Micrometer Screws.* **H. Rosenberg.** (Zeitschr. Instrumentenk. 22. pp. 246–254, Aug.; and pp. 269–275, Sept., 1902.)—If the reading of the screw head, *i.e.*, the angle of rotation, be denoted by L, and the correction to be applied for the periodic inequality is $\phi(L)$ then the latter can be expanded in a series of sines and cosines the values of the coefficients being obtained by the method of "least squares." For the determination of the periodic errors of the screw, readings L_i and L'_i are taken on the screw head, and the measured interval (f_i) between these readings is connected with the true interval (f_o) by means of the equation, $f_o - f_i = \phi(L_i + f_i) - \phi(L_i)$. A first approximation is obtained by neglecting the squares and products of the coefficients and counting f_o for f_i in the expressions *sin.* $\frac{1}{2} f_i$ and *sin.* f_i, and *n* equations of this type are obtained by taking values of *i* from *o* to *n*, for f_o, x_1, y_1, x_2, y_2. Errors of observation are then taken into account, and the equations are developed according to the method of least squares. Where the conditions permit of it, these equations can be greatly simplified by a cyclic arrangement of the measurements, *e.g.*, if the values of L_1 are taken at equal portions of the circumference of the screw head, say at intervals of $2\pi/n$. A second approximation is then proceeded with according to the special circumstances of the case. E. S. A. R.

865. *Frequencies of a Horizontally Suspended Coiled Spring.* **F. J. Rogers.** (Phys. Rev. 15. pp. 374–379, Dec., 1902.)—The paper gives a comparison between theoretically calculated and experimentally observed values of the frequencies. The gravity effect is taken into account as well as the elasticity effect. The spring used consisted of 300 spires of No. 18 wire, each spire 5 cm. in diameter, total length of spring 2·4 m., suspended by 25 pairs of threads 60 cm. long. A mathematical theory is given leading to the frequency equation—

$$N_s = \frac{1}{2\pi}\sqrt{\frac{g}{l} + \frac{s^2\pi^2 F}{4ma^2}}$$

where *a* is length of coil, *l* length of suspending cords, *m* mass of spring per unit length, F force required to double the length of the spring, and the length from node to next antinode for the special harmonic N_s considered is a/s. The first part under the radical expresses the gravity effect, the second the elasticity effect. A table of values of the frequencies of the first ten harmonics is given, showing close agreement between calculated and observed values. J. W. P.

866. *Repetition of Stress.* **F. Foster.** (Mech. Eng. 10. pp. 704–706, Nov. 22, and pp. 740–742, Nov. 29, 1902. Paper read before the Owens College Engineering Society.)—The author suggests a possible explanation of the phenomena caused by repetitions of stress in materials. If a bar receives by any mechanical process an elongation greater than that corresponding to the elastic limit under statical conditions, it will not return to its original form, having entered on the plastic state. Secondly, if a bar receives, in any mechanical way, a deformation equal to that causing fracture under statical conditions, then it will break. Also, if a bar be strained even within the elastic limit there is a time lag or hysteresis in its returning to its original form when the load is removed. If, then, we have a variation of stress from load to no load, the second cycle begins before the extension due to lag on the first cycle has had time to disappear; this produces a greater residual extension at the beginning of the third cycle, and so on, until the elongation becomes



equal to that due to the elastic limit, to the yield point, and finally to the statical elongation, and when this is reached the specimen will break. The diagram is intended to present qualitatively an idea of what is supposed to take place, the amount of lag being considerably exaggerated and the number of cycles shown in each part of the diagram having no quantitative signification. It is obvious that the greater the range of stress, the greater will be the lag per cycle of loading, and consequently the less the number of repetitions necessary to produce fracture. Increase of rapidity of repetition of the load would cause a diminution of the number of repetitions the specimen would stand before fracture, since the lag per cycle would be greater. It would be expected that of two bars having the same range of stress, the one having the higher mean value for the stress would require the less number of repetitions for fracture, since it has less of the elongation in the elastic stage to make up by means of the added lags. The author quotes figures and diagrams from the experimental results of Wöhler and others in support of his theory.
H. R. C.

867. *Stable Equilibrium of a Fluid.* **P. Duhem.** (Comptes Rendus, 135. pp. 1290–1293, Dec. 29, 1902.)—The author considers in this note a homogeneous incompressible fluid, whose elements are subject to forces derived from a potential V, and which is bounded by a surface S_0, on which the pressure is uniform and constant. Let n be the normal to S_0 measured inwards. Then he proves the following theorem: "If dV/dn is not negative at any point of S_0, and is positive at all points of a finite area Σ forming part of S_0, the equilibrium cannot be stable." He assumes an auxiliary function ψ, which satisfies the conditions following, namely: (1) At all points on S_0 $\frac{d^2\psi}{dt^2}+\frac{dV}{dn}\frac{d\psi}{dn}=0$. (2) At all points on Σ $d\psi/dn=0$. (3) At all points in the enclosed space $\Delta\psi=0$. (4) At all points in the enclosed space $d^2\psi/dt^2=0$ when $t=0$. Hence he proves that if $\Omega=\int\frac{dV}{dn}\left(\frac{d\psi}{dn}\right)^2 dS_0$, $d^2\Omega/dt^2$ can never be negative, and can be made to differ from zero, and is therefore positive, and so the equilibrium unstable. The method, he says, is applicable to the two following cases: First, the case of a homogeneous incompressible fluid at uniform constant temperature whose elements are subject to external conservative forces, its bounding surface being under uniform constant pressure. Second, a homogeneous compressible fluid under uniform constant pressure, and subject to no other external force, moving from a state of equilibrium in such way that the specific entropy is a function of the temperature or constant, the same at all points of the fluid. These are, he says, precisely the cases in which the method of Lagrange and Lejeune-Dirichlet enables us to determine the conditions for stability. But they are not precisely the conditions assumed in this paper. The problem of determining the necessary and sufficient conditions is yet, he says, far from being solved. S. H. B.

868. *General Equations of Motion of a Rigid Body.* **A. Wassmuth.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 777–787, May and June, 1902.)—The writer begins with a reference to Kirchhoff's work (Mechanik, 4 Aufl., 1898, 5 and 6 Vorlesung), and points out the great difficulty of the investigation therein contained. In the special case where one point of the body is fixed, we cannot take for independent variables the three angular velocities p, q, r, because, as Routh has shown, the co-ordinates of each point of the body cannot be expressed in terms of p, q, r, without introducing into the geometrical equations differential coefficients according to the time. He proposes a new method. The position of the body is given if we know the co-ordinates α, β, γ, of a point G in the body referred to rectangular axes fixed in space ($\xi\eta\zeta$) and the nine direction cosines of three rectangular axes through G fixed in the body. Between these nine variables exist six relations, which, when Lagrange's equations come to be applied, give rise to six indeterminate multipliers $\lambda_1 \lambda_2 \ldots \lambda_6$. From these data he finds an expression for U′, the work done by the forces, which leads to three Lagrangian equations of the form $d/dt \,.\, dT/d\xi = .\, \Xi$, &c. To find the other nine he introduces the six given conditions—

$$\alpha_1^2 + \alpha_2^2 + \alpha_3^2 = F_1 = 1, \text{ \&c.},$$
$$\alpha_1\alpha_2 + \beta_1\beta_2 + \gamma_1\gamma_2 = F_2 = 0, \text{ \&c.},$$

in the form—

$$\frac{d}{dt}\left(\frac{dT}{ds'}\right) - \frac{dT}{ds} + \lambda_1\frac{dF_1}{ds} + \lambda_2\frac{dF_2}{ds} + . \text{\&c.} = S,$$

where S stands in succession for the nine direction cosines $\alpha_1 \ldots \gamma_3$. By these substitutions he obtains three equations—

$$\frac{d}{dt}\left(\frac{dT}{d\dot{\alpha}_1}\right) - \frac{dT}{d\alpha_1} + 2\lambda_1\alpha_1 + \lambda_3\gamma_1 + \lambda_6\beta_1 = A_1.$$
$$\frac{d}{dt}\left(\frac{dT}{d\dot{\alpha}_2}\right) - \frac{dT}{d\alpha_2} + 2\lambda_1\alpha_2 + \lambda_5\gamma_2 + \lambda_6\beta_2 = A_2.$$
$$\frac{d}{dt}\left(\frac{dT}{d\dot{\alpha}_3}\right) - \frac{dT}{d\alpha_3} + 2\lambda_1\alpha_1 + \lambda_5\gamma_3 + \lambda_6\beta_3 = A_3.$$

Hence he deduces Kirchhoff's equations 14 of the 6th Vorlesung, also equations 12 and 13, and finally obtains the most general equations of the first kind for the motion of a rigid body. For example (18)—

$$\frac{d}{dt}\left(\frac{dT}{d\dot{\alpha}_1}\right) = \frac{d}{dt}\left(\alpha_1\frac{dt}{du} + \alpha_2\frac{dt}{dv} + \alpha_3\frac{dt}{dw}\right) = \Xi, \text{ \&c.}$$

The quantities λ are shown to be moments of rotation. S. H. B.

869. *Stability of Equilibrium in a Viscous System.* **P. Duhem.** (Comptes Rendus, 135. pp. 939–941, Dec. 1, 1902.)—A material system has utilisable energy (denoted by Λ) whenever the following equation is satisfied, namely: $dT_e + dT_p = d\Lambda + d\Theta$, in which Θ is the kinetic energy, T_e the internal work, and T_p the internal work due to viscosity. Such systems are called by the author isothermo-adiabatic. Systems in which all the changes are isothermic or iseutropic are of this nature. If Λ exists, let P be the potential of external force, and $P + \Lambda = \Omega$. Then by the Lejeune-Dirichlet theorem the system is in stable equilibrium when Ω is minimum. The question discussed in this paper is whether it is unstable when Ω is not minimum, but its first derivative is zero. By a suitable choice of the variables $\xi_1 \ldots \xi_n$ which define the system, we can always satisfy the conditions. (1) Equilibrium corresponds to $\xi_1 = .. = \xi_n = 0$; (2) in equilibrium $\Omega = 0$; (3) $\Theta = \xi_1'^2 + . + \xi_n'^2 + \&c.$; $\Omega = S_1\xi_1^2 + . + S_n\xi_n^2$. Liapounoff and Hadamard have proved in the works to which the author refers that if at least one of the coefficients S is negative, the system is in unstable equilibrium. But that is in the absence of viscosity. It is suggested that it might be rendered stable by viscosity. The writer has not completely proved for this case the theorem analogous to that of Liapounoff and Hadamard, but he establishes the following: If one at least

of the coefficients S is negative, and if none of them is positive the equilibrium is unstable. This is proved by the use of the dissipation function of Stokes and Rayleigh. If $V = \Sigma (\xi'^2_p - S_p \xi_p^2)$, he proves that d^2V/dt^2 is positive.

S. H. B.

870. *Stability of Equilibrium of Variables without Inertia.* **P. Duhem.** (Comptes Rendus, 135. pp. 1088–1091, Dec. 15, 1902.)—This is a continuation of a former paper [see preceding Abstract]. He proved in the former paper a theorem converse to that of Lejeune-Dirichlet, assuming viscosity to exist. But the proof was based on the assumption that the kinetic energy contained the time differential coefficients of all the variables. This, he points out, is not the case in thermodynamics. In systems there treated there are variables without inertia, whose first derivatives do not enter into kinetic energy. He here calls such systems those of Chemical Mechanics. As the variables having inertia appear in the kinetic energy but not in the dissipation function, so as regards the variables without inertia the opposite is true. He now assumes the system to be determined by two sets of variables, namely, $\xi_1, \xi_2 \,.\,.\, \xi_m$ having inertia, and $\eta_1, \eta_2 \,.\,.\, \eta_n$ without inertia. The conditions (1), (2), (3) of the former paper now become: (1) In equilibrium $\xi_1 \ldots \xi_m = 0$, $\eta_1 \ldots \eta_n = 0$; (2) $\Omega = 0$; (3) $\Theta = \Sigma \xi'^2$, $F = \Sigma \eta'^2$; $\Omega = S_1 \xi_1^2 + \ldots + S_m \xi_m^2 + \sigma_1 \eta_1^2 + \,.\,.\, + \sigma_n \eta_n^2$. And he proves as in the former paper that $d^2V/dt^2 > 0$, if one only of the coefficients S_1 σ is negative.

S. H. B.

871. *Volcanic Eruptions on Martinique.* **Lacroix.** (Comptes Rendus, 135. pp. 1301–1307, Dec. 29, 1902.)—During November and December the author several times saw dark, dense, enormous vapour clouds, in constant movement like balls of cotton, roll down the Mt. Pelée to the sea, traversing the distance of 6 km. in six or nine minutes, and darkening the sea on which they disperse for several hours. While descending they also rose slowly to an elevation of 3,000 m. They carry with them ashes and also lapilli and lava in large quantities; the ashes are white and exceedingly fine. From the same part of the cone where the vapour clouds issue, come also, sometimes without interruption, incandescent blocks which break up as they roll down the mountain; they are not thrown up high by the volcano, no explosive eruptions having been noticed in those weeks. The block fragments near the sea are up to 100 m. in size. H. B.

872. *Free Hydrogen in the Atmosphere and the Density of Atmospheric Nitrogen.* **A. Gautier.** (Comptes Rendus, 135. pp. 1025–1032, Dec. 8, 1902.)—The author's estimate of the amount of free hydrogen contained in the atmosphere—about 0·0002 of the volume—having been questioned by A. Leduc and Rayleigh [see Abstract No. 751 (1903)], the author replies to these criticisms. He finds fault with Leduc's method of calculating, charging him with inconsistency as regards the meaning of the density of atmospheric nitrogen. Rayleigh's objections were based on comparative spectroscopic tests and on direct combustion tests; the latter the author criticises as discordant in themselves. The author finally regrets that, in spite of Regnault's warnings, densities are still referred to air as unity; the density of the air varies with the locality, town or country, mountain or sea, as he has shown. He does not mention any fresh experiments. H. B.

873. *Pre-determination of the Air Pressure Variations for the following Day.* **F. M. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 707–725, May and June, 1902.)—From the data of the synoptic charts of one day the author deduces a merely hydrodynamical, differential equation, not permitting of integration for the air currents of the following day. Thermal influences are not allowed for; the rotation of the earth and dynamical friction are considered. The author points to the peculiar influence of mountain barriers. When a south wind blows over Italy, the isobars are bulged out (towards S.E.) on the eastern coast of Italy, marking a relative depression there which is not noticeable on the west coast and on the Dalmatian coast; with a north wind, the depression appears on these latter coasts. The formula is tested for Vienna, Paris, Stockholm, &c., with satisfactory results. The computation of the constants would, however, be very tedious, though the constants seem to be principally the same for all isobar configurations, and affected only by the geographical influences which vary with the wind direction. H. B.

874. *Similarity of Short-Period Pressure Variations over Large Areas.* **N. Lockyer** and **W. J. S. Lockyer.** (Roy. Soc., Proc. 71. pp. 134–135, Dec. 27, 1902.)—The authors have continued the investigations mentioned in Abstracts Nos. 198 and 291 (1903) on the existence of a short-period oscillation of barometric pressure corresponding with a variation in the percentage number of prominences. The monthly means of pressure variations for each station are divided into two periods, namely, months in which the pressures are above, and those in which they are below the normal. The investigation now concerns India, Ceylon, Java, Australia (Perth, Adelaide, Sydney), Cordoba in South America, and a corresponding region north of the equator, namely, Mobile (Alabama), Jacksonville and Pensacola (Florida), and San Diego (California). In southern latitudes the high pressure months are generally April to September, in northern October to March. Comparison of the curves, in most places covering the period 1875 to 1900, is to show that the pressure variations over large areas are similar, but the inverse of those recorded in nearly antipodal parts, so that the same kind of variations would be in action over northern and southern latitudes. H. B.

875. *The Meteorological Effects of the Solar and Terrestrial Physical Processes.* **F. H. Bigelow.** (Monthly Weather Rev. 30. pp. 559–567, Dec., 1902. Paper read before the Physics Section, B, of the A. A. A. S. at the Washington, D. C., Meeting, Dec. 28, 1902.)—The author gives an explanation of the double diurnal periods in the meteorological elements in the atmosphere at the earth's surface. At some distance above the ground the periods are all single, and these he considers to be due to the effects of the incoming solar radiation, while at the earth's surface the two periods are due to the added effect of the terrestrial radiation. Calculated on the Wien-Paschen formula, curves are given of the solar and terrestrial radiation for different temperatures, the former being reduced to the distance of the earth. The maximum radiation of the earth consists of waves of about 8 to 10 μ which are specially readily absorbed by the aqueous vapour in the air, and the increase of temperature causes the vapour layers to rise, their place being filled by surface evaporation. At noon, as the whole temperature rises, the vapour capacity rises, and, as the surface evaporation has become slower owing to the prevailing moisture having been taken up at an earlier hour, the surface air volumes become depleted of moisture; a minimum in the humidity curve therefore occurs at about 3 p.m. The second maximum is due to the processes taking place in the reverse-direction. Similar reasoning is applied to explain the other diurnal curves. E. C. C. B.

876. *Cloudbursts.* **A. D. Elmer.** (Monthly Weather Rev. 30. p. 478, Oct., 1902.)—Cyclonic thunderstorms as a rule move slantingly. If we imagine the storm area to be rectangular, then it may move broadside on, longitudinally, or slantingly. In the first case, the observer experiences a tornado of short duration, and there is not much rain on the spot; the case is rare. In the second case, the storm travels slowly along its long axis; the observer experiences a calm, and very heavy rain continues for a long time. This is what people call cloudbursts. The author has observed two such storms rising to 1,400 and 2,500 ft. respectively. H. B.

877. *Cycles of Precipitation in Utah.* **L. H. Murdoch.** (Monthly Weather Rev. 30. pp. 482–485, Oct., 1902.)—The Great Salt Lake is the remnant of an enormous lake basin which must at one time have been 1,000 ft. deeper than at present. The author finds that since 1856, and probably since 1827, the level of the lake and the precipitation curves have kept fairly parallel; but since 1889 the lake level has steadily decreased, while the rainfall has not much changed. For Salt Lake City, there was a dry cycle from 1827 to 1864 (average annual rainfall 15 in.), a wet cycle from 1865 to 1886 (average 18·4 in.), and a dry cycle again from 1887 to 1901 (rainfall 15 in.). H. B.

878. *Meteorology of the Equator at Pará and Gaboon.* **J. Hann.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 615–683, May and June, 1902.)—The paper is essentially a discussion of the data collected by E. Goeldi in Pará (Brazil) during the years 1885 to 1901, supplemented by observations taken by E. Engelenburg during the magnetic survey of North-east Brazil in 1883–84. Detailed comparative references are made to the meteorology of the estuary of the Gaboon (opposite Pará, in West Africa) as recorded by Soyaux, A. von Danckelman, and also by Vincent; further, to the Island of S. Thomé (Gulf of Guinea), Equateurville (Congo State), and Quito. The climate of Pará is remarkably equable, the monthly temperature means do not differ by more than 1·4° C.; even the monthly extremes remain the same for years. The variations of the barometer show no connection with the cloudiness and rainfall; the diurnal variations are similar to those at Gaboon, but smaller. The mean barometer at Pará is 758·3 mm., just as at Guyaquil, on the East Coast of South America, 758·0 mm. The mean annual temperature of Pará is 25·7° C., 2° lower than the figure of the *Challenger* reports; the author considers that most equatorial temperatnres have been over-rated. The daily variation is about 9°; the mean temperature remains constant from May to September; the maximum occurs when the sun is the second time in the zenith, the minimum coincides nearly with the first zenith position; this is not so at Gaboon. The relative humidity is always high at both places and varies more at Gaboon; in the mornings and evenings the air is saturated with moisture. The cloudiness is greater at Gaboon than at Pará. There is a kind of rainy season at Pará from January to April, followed by a drier period to December, during which rains are also frequent, however. Thunderstorms occur on 170 days at Pará, mostly in the afternoons, and these storms begin later as the year advances, at 3·4 h. in January and at 5·6 h. in September. The average daily rainfall is 9 mm. at Pará (131 mm. maximum), 13 mm. at Gaboon (153 mm. maximum). Winds from

north-east and east predominate at Pará; there is no regular diurnal change in the direction of the winds, but there is in their force. At Gaboon, south-west winds prevail, and their direction changes in the course of the day.
H. B.

879. *Meteorology of Geneva and the Great St. Bernard in* **1901. R. Gautier.** (Archives des Sciences, 14. pp. 564–589 and 601–608, Nov.; and pp. 650–687, Dec., 1902.)—The observations, referred to in Abstract No. 646 (1902), have been continued on the same plan. The averages are computed, as before, both for the civil and the meteorological year. On the St. Bernard seven readings are taken daily in the old station, and three with thermometers and hair hygrometers in the new station; the observers are Prior Gard and the brothers. The difference between the two sets of thermometers amounts to 0·46° maximum. The year was rather wet and cold, particularly on the St. Bernard, where a hot summer was more than counterbalanced by the other cold seasons; in Geneva both autumn and winter were cold. February was the coldest month with mean temperatures of —2·34° (Geneva) and —15·28° (St. Bernard); July the hottest, means +19·25° and +6·91°. The extremes were —14° and +31·2° (Geneva) and —26·4° and +19·5° (St. Bernard). The amplitudes of the extreme pressure variations differ a little more from the averages of Plantamour, but are not striking either. The pressure means, based upon eight, and upon three, daily observations respectively, in no case differ by as much as 0·1 mm. The new hair hygrometers on the St. Bernard recorded zero humidity twice on November 21, 1901. May is the driest month in Geneva, October on the St. Bernard. In Geneva sunshine is more frequent in the afternoon than in the morning, and the wind velocity twelve times exceeded 25 km. H. B.

880. *Anomalous Dispersion Theory of Sun's Chromosphere.* **W. H. Julius.** (Phys. Zeitschr. 4. pp. 132–136, Nov. 15, 1902.)—The objections to the above theory raised by Wilsing and others are discussed, and it is concluded that the light from the chromosphere and the protuberances is to be ascribed almost exclusively to anomalous dispersion, and only in a small degree to general refraction. G. E. A.

881. *Theory of Solar Protuberances.* **W. H. Julius.** (Archives Néerlandaises, 7. pp. 473–483, 1902.)—This is an attempt to explain the nature of solar protuberances by anomalous dispersion. In former papers [see Abstracts Nos. 33 (1901) and 25 (1903)] the author had suggested the following hypothesis relative to the constitution of the part of the solar atmosphere exterior to the so-called photosphere: The various elements, the presence of which in the atmosphere of the sun has been inferred from spectral analysis, are much more widespread than had formerly been assumed on the nature of luminous phenomena. They may occur even over great distances beyond the photosphere, and still be visible only at some places, their own radiation contributing very little towards rendering them visible; the distances beyond the edge of the disc of the sun at which the characteristic light of the substances is seen is mainly determined by local variations in their density, in connection with their property of giving rise to anomalous dispersion. No hypothesis as to the origin of chromospheric light had been made, as nothing had been said about the interior of the photosphere. In order to continue these considerations, the author makes use of the three propositions by which Schmidt resumes the principal points of his theory, according to which the surface of the photosphere is not the limit of a body but a sort of *critical sphere*, defined by the property that its radius is equal to the radius of curvature of the horizontal light rays passing through a point of its surface. On this theory, not only the edge of the photosphere is formed by regular reflection, but even the protuberances would be produced by reflection in the "*Schlieren*." Now, in order to account for the fact that the light from these protuberances and from the chromosphere is not white, but shows a line spectrum of variable aspect, Schmidt considers the strongly radiating part of the gaseous mass to be constituted so that the exterior part would emit almost exclusively the light of hydrogen, calcium, and helium, whereas sodium, magnesium, titanium, and iron radiations would come from the inner layers. By the use of the principle of anomalous dispersion it is, however, possible to assume that the mixture of various substances is present in the whole of the gaseous mass, inside as well as outside of the critical sphere. Wherever streams, vortices, &c., give rise to differences in the density of the gaseous mixture, the conditions for an irregular curvature of the rays are given, it being evident that out of the substances present in the mixture those possessing very strong specific dispersion for certain kinds of the transmitted light will be detected over particularly wide distances beyond the solar disc, whereas others, though equally present, will remain invisible. The fact that various gases of the sun appear to be separated, though no real separation is presumed, is thus accounted for in a purely optical way. This latter hypothesis, he also shows, is a necessary consequence of the representation of the sun as a gaseous, rotating mass giving off heat, as a continuous mixture of the elements such a body is made up of must of necessity take place. Similar considerations have been suggested by R. Emden [see Abstract No. 1036 (1902)], and some mathematical deductions as made by Helmholtz apply to the phenomena occurring on the sun, though Emden admits the mass of the sun to be limited by a surface in accordance with the views most generally adopted. As, however, his mathematical considerations are quite independent of the existence of such a limit, they may equally well be applied to a sun such as defined by the author. The external layers of the gaseous mass being most rapidly cooled by radiation, will gradually descend, and be replaced by rising gases, being warmer, so that, but for the rotation of the sun, only radial currents would be met with. On account of the rotation about the axis, these currents, however, are considerably modified, the angular velocity of the descending masses increasing, whereas that of the rising masses will be diminished; gaseous layers of different densities, rotating at different speeds, are thus obtained beside one another. As shown by Helmholtz, such gaseous layers are susceptible of a relative motion for some time, without their becoming intermixed; on account, however, of the friction, this surface gradually takes the form of a wave surface, the waves being propagated along with the layer, the velocity of which is most considerable, so as to form by the mixture of two neighbouring surfaces a new layer, the properties of which will, as a rule, be intermediate between the corresponding properties of the primitive layers. The behaviour of these surfaces has been deduced by Emden in a manner similar to what has been done by Helmholtz in the case of the currents of atmosphere, the result being arrived at that the surfaces of discontinuity will have a form similar to a hyperboloid of revolution. It may, however, easily be understood that similar surfaces will nowhere occur in the whole of their extension, but fragments of such surfaces, the general character of which will be the same, are likely to be met with everywhere. Though a continuous mixture, compensating differences in speed will take place, the state of motion must somehow remain stationary; inside of each layer, temporarily included between two surfaces of discontinuity, convection currents will continuously convey cool substance downwards, warm matter rising at the same time, so as to re-establish continuously the differences in speed. The author now contends that the whole of the chromosphere with all its protuberances is constituted by this system of waves and vortices made visible up to distances more or less great beyond the edge of the sun, in virtue of the anomalous dispersion of the photospheric light. The chromosphere is ascribed to the relatively small vortices, the continuous winding-up of the surfaces of discontinuity, whereas the protuberances are regarded as the vortices the very great waves of the solar sea are transformed into. Many instances in favour of these views are derived from a recent paper by Fényi. On the above theory many apparent contradictions afforded by the enormous velocity of propagation of solar protuberances are easily done away with. In fact, the term velocity may be applied only to a displacement of matter or to the propagation of a chemical phenomenon, or finally, of a state of movement. Nothing of the kind, however, is met with in the present case, as the formation of vortices takes place only under the influence of the local state of the matter, and is not due directly to a similar motion pre-existing at other places. The phenomena in question are comparable to the propagation of the waves of the sea, where also there is no velocity proper. A. G.

882. *The Meteorite of October* 3, 1901. **G. v. Niessl.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 1074–1131, July, 1902.)—The meteorite was seen at 7 h. 22 m. in the evening (Central European time) over an area of 800 by 680 km., extending from the Northern Adriatic to Magdeburg. The author examined more than two hundred accounts, partly reproduced in the paper. Although they differ widely, some parts are fairly settled. First seen in Pegasus as a shooting star at a height estimated by the author at from 100 to 315 km., the meteorite increased rapidly in brilliancy and size as it descended almost vertically. The light is described as resembling that of an arc lamp, or greenish or bluish, the shape as that of a ball (half to twice the size of the moon) with conical projections, or of a pear; a trail was observed. The meteorite seemed to stop and to separate into several parts—but the accounts disagree strangely on this point; the colour changed to red; the reports of fragments found and detonations are unreliable. The stopping took place above Jessenitz, in the centre of Bohemia, at a height computed at 42 km.; the fall lasted about four seconds at a rate of 34 km. per second. The author believes that the meteorite consisted, as usually, not of one mass, but of a cloud of particles; the finer particles quickly passed through incandescence, then disclosing the reddish, coarser particles inside. This would be the apparent explosion; the increase in size was probably real, and the character was about 1,250 m. The cosmical radiating point is computed at 287·7° longitude, and 30·2° northern latitude (ecliptic), that is a spot not very far from the apparent apex of our solar system. The author points out that this radiant would fit many of the shooting stars and meteorites, apparently starting from different portions of the sky in different seasons. H. B.

LIGHT.

883. *Light Scattered and Transmitted by Fine Particles.* **J. Barnes.** (Phys. Rev. 15. pp. 368–373, Dec., 1902.)—When a ray of sunlight is passed into a tank of distilled water to which a few drops of an alcoholic solution of mastic have been added, Tyndall's blue cloud effect is obtained, the beam being of a more decided blue at the beginning than at the end. With a larger quantity of mastic in suspension, the light scattered from the end of the path is a dim red. The part of the incident light cut off in transmission was ascertained by passing the beam of sunlight through a Steinheil spectroscope with the telescope removed. The rays then passed into a rectangular tank so that the water surface divides the spectrum in two. It was found that for $\lambda = 410$, $xn^{2 \cdot 5} = \text{constant}$, where x is the distance penetrated, and n is the amount of mastic solution present which may be taken as proportional to the number of particles present. With increase of wavelength the exponent of n approaches unity. G. E. A.

884. *Primary Colour Sensation.* **F. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 857–877, May and June, 1902.)—The three curves of primary colour sensation of the Young-Helmholtz system cut each other in four points, *a*, *b*, *c*, and *d*, beginning at the red. The point *a* corresponds to the colour complementary to primary blue, *b* gives the wave-length of primary green, *c* the complement to red, and *d* the wave-length of primary blue. A spectrum 1 metre long, formed by means of an arc lamp and a large concave grating, was observed through a dichroscopic lens, a large nicol being placed between the lens and the eye. On turning the nicol from the position for equal brightness, the dark and bright halves of the field changed colour in opposite senses for positions on opposite sides of the point *a*. The points *a*, *b*, &c., were thus determined within narrow limits, the mean results for four observers being, for *a*, *b*, and *d*, λ577, 508, and 475, and for *c*, by the author's observations, λ494. The method is free from the somewhat debatable assumptions which underlie the methods of König and Dieterici. G. E. A.

885. *Phenomena of Radiation.* **L. Graetz.** (Phys. Zeitschr. 4. pp. 160–161, Dec. 1, 1902.)—As against J. W. Russell's explanation of the action of certain metals and substances upon photographic plates as being due to H_2O_2 (Proc. Roy. Soc. 64. 409, 1899), the author shows that the actions referred to traverse thin layers of gold or aluminium, and that they remain even when all H_2O_2 vapours are driven away by a strong blast of air. They are not due to negative electrons. They travel in straight lines until they reach the photographic plate, but then there is no regular reflexion. A plate is exposed to H_2O_2 vapours and then a metallic object is laid on the glass side of the plate; on developing the plate the metallic object appears bright on a dark ground. The effect of the metallic object is not destroyed by interposing black paper, ebonite or wood between it and the glass, and intervening liquids rather heighten the effect sometimes. Water has this effect; so have saline solutions, alcohol, and especially ammonia. If a plate has figures drawn on its glass side with a match dipped in water or ammonia, and be then exposed on the film side to H_2O_2 vapours, these figures come out dark and rather diffuse upon development. Laying metallic objects upon wet paper on the glass side brings out differences between the effects of the different metals scarcely perceptible in the absence of the wetted paper; and this serves as a means of detecting the slightest chemical action between the metal and the solution with which the paper is wetted. The cause seems to be the resultant rise in temperature, even though this do not exceed 0·01 to 0·02°, the warmer part developing out thinnest. This method opens up a method for photography of the infra-red spectrum under the influence of H_2O_2 vapours or rather of unknown emanations from these. A. D.

886. *Sensitometry of Photographic Plates.* **J. M. Eder.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 888–893, July, 1902.)—Experiments on direct blackening of Ag Br films sensitised by dye-stuffs. An erythrosin-dyed plate (Schattera's) gave results when exposed to the spectrum (minutes to hours) astonishingly like those obtained from short exposures followed by development. Eosin dye-stuffs in general have this effect; as also strong cyanin solution, formyl-violet, cyclamin, and chinolin-red, but not alizarine-blue-sulphite. Schattera's plates sensitised for red did not give this result: it gave green, not black, and that only in the blue and violet; but where a black colour is produced directly by exposure, the rule applies that for many dye-stuffs the results of direct exposure, or of short exposure and development, are approximately the same; but the blacks obtained by development may be far denser than those obtained by direct exposure, which for erythrosin-dyed plates must be from 10,000 to 20,000 times the exposure required for subsequent development. [See also Abstract No. 214 (1903).] A. D.

887. *Photographic Dry Plates.* **K. Schaum** and **V. Bellach.** (Phys. Zeitschr. 4. pp. 190–194, Dec. 15, 1902.)—This is a continuation of a former paper [see Abstract No. 793 (1903)]. Where the Ag Br granules in a dry plate (Schleussner Normal) were 270,000 per sq. mm. in the superficial layer, the granules of silver in the developed plate did not exceed 82,000; there was some agglomeration, but many of the particles escaped development altogether. The size of the silver particles increases with the exposure (both as to duration and as to brightness) and with the duration of development. Long development may make the Ag granules larger than the original Ag Br granules. When the plate is solarised the average size of the granules is smaller than under normal exposures, and it decreases with increasing solarisation. When the plate is exposed, fixed and then developed (secondary development, in Neuhauss's developer, water 100 c.c., $Ag\,NO_3$ 4 grm., ammonium sulphocyanide 24 grm., sodium sulphite 24 grm., sodium thiosulphite (hypo) 5 grm. KBr 10 per cent. solution six drops; of this take 3 vols., add 27 of water and 1 of rodinal, the size of the granules depends not only on the exposure but also on the duration of the development. Candle at 2 metres 10 to 50 secs., development 17 hours, granules $1{\cdot}0$ to $1{\cdot}7\mu^2$; 50 secs. at 2 metres, development 24 and 48 hours, silver granules $0{\cdot}9$ and $2{\cdot}1\mu^2$ respectively. The granules under this method are nearly spherical instead of being irregular in form. The opacity of a negative depends not only upon the number and the distribution of the silver particles, but also on their size, which depends upon the ripening of the plate, the exposure, and the mode of development. A. D.

888. *Magnetic Rotation of the Plane of Polarisation in Liquid Oxygen.* **F. Harms.** (Phys. Zeitschr. 4. pp. 158–160, Dec. 1, 1902.)—The author has determined the order of magnitude of the Verdet constant for liquid oxygen. The oxygen was contained in a brass vessel surrounded by jackets

of liquid air and placed between the poles of a Ruhmkorff electromagnet. The polarised light was reflected back to the analyser from a mirror placed at the bottom of the oxygen. Carbon bisulphide (and also benzene) was examined in the same apparatus, with the result that the value of $\alpha 0_2$(liquid)$/\alpha cs_2$ was found to be 0·20, with a possible error of 10 per cent.; this value is in accordance with the view that Becquerel's formula, $\alpha/\alpha cs_2 . 1/n^2(n^2 - 1) = K$, is applicable to oxygen (as to carbon bisulphide and sulphur dioxide) in both the liquid and gaseous states. The following modification of a table drawn up by du Bois contains the value of the Verdet and derived constants for oxygen and other substances: x is the magnetic susceptibility, ω is the Verdet constant in c.g.s. units, $\phi = \omega/x$ for feebly magnetic substances, $\phi = \omega (1 + 4\pi x)/x$ for strongly magnetic bodies.

	$x \times 10$	$\omega \times 10^5$	ϕ
Fe	—	—	+ 2·63
Ni	—	—	+ 3·15
Co	—	—	+ 3·99
O_2 (liquid)	+ 22·8	+ 0·24	+ 0·011
$FeCl_3$ (40 per cent.)...	+ 6·4	− 2·4	− 0·38
O_2 (1 atmos.)............	+ 0·0126	+ 0·000179	+ 0·014
C_2H_5OH..................	− 0·0566	+ 0·330	− 5·8
H_2O	− 0·0694	+ 0·377	− 5·4
CS_2	− 0·0716	+ 1·222	− 17·1

D. H. J.

889. *Rotary Polarisation and Convection.* **Rayleigh.** (Phil. Mag. 4. pp. 215–220, Aug., 1902.)—The question as to whether the rotation of the plane of polarisation of light propagated along the axis of a quartz crystal is affected by the direction of this axis relatively to that of the earth's orbital motion, was considered some time ago by Lorentz. He arrived theoretically at the conclusion that a first order effect might be anticipated, and that the effect of changing the direction from coincidence with the earth's direction of motion to the reverse might amount to 1/10,000 of the whole rotation. The author describes a very carefully made experimental test, in which the rotation produced exceeded 15 complete revolutions. The result showed that there was certainly not a difference amounting to as much as 1/20 of a degree, *i.e.*, 1/100,000 of the whole rotation, and that in all probability, if such an effect existed at all, it was for smaller than this. Larmor criticised Lorentz's conclusion in "Æther and Matter," but Lorentz [see Abstract No. 1680 (1902)] maintains his conclusion.

G. W. DE T.

890. *Rotary Polarisation and Convection.* **J. Larmor.** (Phil Mag. 4. pp. 367–370, Sept., 1902.)—In this paper the author admits the validity of Lorentz's reply to his criticism, referred to in the preceding Abstract. The latter showed that, while convection would not affect the coefficient of magnetic rotation, it would modify the structural coefficient. The author points out that Rayleigh's result therefore tends to show that in the more complex circumstances of rotational media, as well as in ordinary optical propagation in matter, the electrons connecting matter and ether interact in all their relations according to laws of purely electrodynamic type. The atomic character of electrification, with or without a distinct material basis, has the effect that when the medium is convected the electrons exert the ordinary electrodynamic influence of moving charges. Uniform convection will, therefore, produce no first order effects on the electrical and optical properties of media. He considers it to be established that there will be no second order effects if material molecules are entirely electric. If this is the case, it would account for the negative second order observation of Michelson and Morley. G. W. DE T.

891. *Thermal Development of the Spark Spectra of Carbon.* **H. Crew** and **J. C. Baker.** (Amer. Acad., Proc. 38. No. 12. pp. 397–406, Dec., 1902.)—An electric arc was first developed between two carbon poles, and when these were thoroughly hot the arc was stopped and the spark was turned on; as the electrodes cooled, the character of the spark changed slowly from the arc to the spark discharge. The spectrum of the spark was photographed at definite intervals after the spark had been turned on. Exposures of one second were given, and the whole cycle, including the exposure, was automatically repeated many times in order to ensure sufficient density in the photograph. The region of the spectrum examined was between $\lambda = 4500$ and $\lambda = 3000$, and the following are the chief results that were obtained. The cyanogen bands are present with the same relative intensity at all the stages. Carbon lines are few in this region; the line at $\lambda = 4556{\cdot}3$ does not appear in the hot spark, not does the line at $\lambda = 4267{\cdot}5$, and as the latter disappears from the cold spark when self-induction is introduced it is probable that it does not belong to carbon. The line at $\lambda = 3361$ is persistent in the hot spark, and as to the remaining lines at $\lambda = 3920$, 3877, and 3840, they could not be recognised. The air lines do not appear with the hottest spark, but only appear on cooling, while the nitrogen flutings behave in an exactly opposite manner. Of metallic lines the two strongest are the two potassium lines at $\lambda = 4047{\cdot}3$ and $4044{\cdot}3$, but these only appear in the hot spark. Some lines of an element may be enhanced on cooling and others diminished, but lines belonging to one natural series are all similarly affected. E. C. C. B.

892. *Flame Spectra.* **C. de Watteville.** (Comptes Rendus, 135. pp. 1329–1332, Dec. 29, 1902.)—The author has examined the flame spectra of metallic salts produced in the inner core of a bunsen flame, and finds that the results are different from those usually obtained, the lines in the new spectra not being visible in the ordinary flame spectra. These results confirm Gouy's observations (Ann. Chim. et Phys. 18, 1879), and the experimental methods were the same as those employed by him. Salts of about nineteen metals were tried, and the spectra were photographed by means of a Rowland grating, and the following results obtained. The spectra extended some distance into the ultra-violet: for example, the tin line at $\lambda = 2269$ was visible. All the lines observed are common to the arc and spark spectra, but the characteristic spark lines were not present in the flame spectra. The strong arc lines, however, were to be found with the same relative intensities upon the plates. The flame spectra and the oscillating spark spectra (Hemsalech) are identical, with the exception of a few rays in the latter, which were probably too weak in the former to affect the photographic plate. This similarity is especially pronounced in the case of iron, nickel, cobalt and manganese, the two spectra being in certain regions undistinguishable. The author concludes that the temperature is the only factor which determines the nature of the spectra. E. C. C. B.

893. *Photo-electric Activity of Substances Coloured by Becquerel Rays.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 4. pp. 113–114, Nov. 1, 1902.)—

Photo-electric dispersion of negative charges decreases with increasing wave-length of the incident light, so that the list of substances presenting this property rapidly diminishes with increase in this wave-length. For ultra-violet light it is almost a general property of matter: for sunlight and diffused daylight the list is Zn, Mg, Al, Na, K, Ru, Cs and their amalgams, phosphorescent sulphur compounds of the alkaline earth metals, and halogen compounds of the alkali and alkaline earth metals which have a colour occurring naturally (blue fluorite) or induced by the action of K or Na vapours on the uncoloured salts; as also chlorides and other salts coloured in an analogous way by the action of Becquerel rays or of radium emanations, the colours produced being often so fugitive that they are completely discharged in the course of the experiment under the influence of sunlight or daylight. A. D.

894. *Radio-Active Emanations from the Soil.* **H. Ebert** and **P. Ewers.** (Phys. Zeitschr. 4. pp. 162–166, Dec. 1, 1902.)—The radio-active air from the capillaries of the soil can be removed in metal tubes and kept in zinc gas-holders. Positive charges are more rapidly discharged by it than negative; the negative electrons move more rapidly past with their charges than positive ones do. Removal of CO_2 and H_2O vapour seems to remove a large proportion of the negative, not of the positive electrons. On storing the air there is at first a rapid rise in the dispersive power, then a steady slow fall-off. The electrons appear to be few, and even after removing all electrons by an electric field, the air still had a powerful ionising activity, which points to the presence of a radio-active emanation, electrically neutral. This renders active the walls of the glass bell, &c. The activity of this emanation is reduced but not destroyed by heating the air to a red heat. This air will render ordinary air, at rest, also active in the course of some time. A. D.

REFERENCES.

895. *Refractive Indices Measured by Talbot's Fringes.* **K. Tsuruta.** (Phys. Rev. 15. pp. 380–382, Dec., 1902.)—The Talbot fringes obtained from a hand spectroscope with direct vision, with the addition of a cover-glass plate fixed between the prisms and the Ramsden eyepiece, are employed in determining refractive indices, the above apparatus being used in conjunction with a Pulfrich total reflectometer. The cover-glass is cut with a diamond and fixed so as to cover half the field. G. E. A.

896. *Technical Photo-microscopy of Metals.* **M. A. Richards.** (Metallographist, 6. pp. 71–80, Jan., 1903. From the Journ. of Applied Microscopy, Aug., 1902.)—Description of the process of polishing, etching, mounting, and photographing specimens of iron and steel, and recording the results, as practised by steel companies. A. D.

897. *Actinometer.* **H. v. Schrötter.** (Deutsch Phys. Gesell., Verh. 4. 13. p. 296, Sept. 25, 1902. Paper read before the 74 Naturforscherversammlung at Carlsbad.)—Actinometer for use in balloons or on glaciers, with direct comparison of the overlight and the underlight. Details promised later. A. D.

898. *The Infra-red Spectrum of Iron.* **H. Lehmann.** (Ann. d. Physik, 9. 5. pp. 1330–1333, Dec., 1902.)—The author has photographed the infra-red spectrum of iron between the limits $\lambda = 8700$ and $\lambda = 6810$; the method has been previously described [see Abstract No. 1880 (1901)]. About 60 lines were measured with a mean probable error of about 0·04 tenth metre, and the wave-lengths are given in the paper. E. C. C. B.

HEAT.

899. *Expansion of Gases under Constant Pressure.* **T. W. Richards** and **K. L. Mark.** (Amer. Acad., Proc. 38. No. 14. pp. 417–428, Dec., 1902.)—Experiments by a new apparatus upon hydrogen, nitrogen and carbon dioxide are given. The desirability of new determinations is pointed out, and the apparatus now used has the following advantages: The gas is all at a known temperature, pressure is measured to one-hundredth of a mm. of mercury, a small temperature interval is used, and the pressure observations are always made under similar conditions. An accuracy of 1 in 3,600 is attained. For hydrogen the coefficient is found to be 0·003659, for nitrogen (impure) 0·003660, for carbon dioxide 0·003727. For maintaining constant temperatures sodic sulphate is here for the first time used on a large scale.

J. W. P.

900. *Thermic Properties of Solids and Liquids.* **S. Lussana.** (N. Cimento, 4. pp. 371–389, Dec., 1902.)—By dilatometer methods, the fusing point of pure phosphorus is $T = 44 \cdot 24 + 0{\cdot}0298p - 0{\cdot}000000{,}66p^2$ where p is the pressure in kgr. per cm.^{2}; the volume of fused phosphorus at temperature t is $1 + 0{\cdot}000532{,}82(t - 44{\cdot}27)$, that of superfused phosphorus is $1 + 0{\cdot}000515168$ $(t - 44{\cdot}27)$, and that of solid phosphorus is $1 + 0{\cdot}000390596t$. Naphthalene (alpha) fuses at 94·4° at atmospheric pressure, the fusing point rising 0·0225° per atmosphere pressure.

A. D.

901. *Transition Temperature of Sodic Sulphate.* **T. W. Richards** and **R. C. Wells.** (Amer. Acad., Proc. 38. No. 15. pp. 431–440, Dec., 1902.)—This paper gives a further determination of the transition point and verifies closely those given in Amer. Jour. Sc. (4), 6, 201. The exact point is on the International Hydrogen Scale 32·383 ± 0·001. The determinations were made by means of four thermometers standardised by the Bureau International des Poids et Mesures. A full description and drawing of the apparatus are given. The sodic sulphate is placed in a large test tube in a Beckman freezing-point apparatus. This is surrounded by an air jacket. The outside bath is maintained about half a degree above the transition temperature by a small platinum resistance coil in the water. The determinations made from various samples of the salt and by the different thermometers are in close agreement. The transition point is recommended as a "fixed point" for thermometry on various grounds.

J. W. P.

902. *Application of the Kinetic Theory to Diatomic Gases.* **W. Walker.** (Roy. Soc., Proc. 68. pp. 77–78, March 25, 1901, and 69. pp. 394–398, March 7, 1902. Extended Abstract.)—A molecule in this paper is supposed to consist of two atoms of equal or unequal masses, with equal and opposite electrical charges. They are of three kinds, namely, A, in which the two atoms revolve round each other in continuous contact; B, in which they revolve round each other in elliptic orbits of finite dimensions; C, in which the orbits are hyperbolic—so that practically C consists of two atoms generally free, but temporarily united while within range of each other's attraction. The exact distinction between A and B is not defined. Molecules having this nature,

the writer assumes them to be in motion with velocities distributed according to the Maxwell-Boltzmann law. That, however, seems to be unintelligible as applied to C, unless the atom is substituted for the molecule. He assumes that the number of each class will be on average constant, however individual molecules may undergo dissociation, or two atoms unite to form a more or less permanent molecule (A or B). The molecules, he says, will be mainly of class A owing to the greater energy, or less potential energy. The assumption that some molecules (C) are always dissociated agrees with experiment. As pressure diminishes the numbers of B and C together diminish, but the proportion of C to B increases. This accounts for the increased ease with which electrical discharge takes place under reduced pressure. The author next considers the magnetic effect due to the free atoms. He shows that the molecules contribute positive magnetic susceptibility agreeing with Quincke's experiments. The dielectric constant is found to be $K = 1 + kp/\theta^2$, where θ is the absolute temperature and k a constant of the gas. The result usually given is $K = 1 + kp/\theta$; the difference is explained by the analysis. In dealing with optical effects the writer considers first the free atoms and their effect on light waves. The free atoms accelerate the rate of propagation by an amount proportional to the square of the wave-length; with respect to the molecules the distribution law has in presence of waves to be modified, owing to the molecules assuming special orientations. The coefficient of rotation of the plane of polarisation in a magnetic field is obtained, and is found to vanish if the positive and negative atoms have equal masses. The angular velocity of rotation of mean square $(\overline{\omega})$ must, he says, correspond to a frequency beyond the violet of the spectrum. Hence spectral lines cannot be explained by the molecules of this theory. The writer considers them to be due to multiple molecules—which also have important bearing on the ratio of the specific heats. S. H. B.

903. *Internal Pressure, Internal Friction, Dimensions, and Mean Free Path of Molecules of Liquids.* **G. Jäger.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 697–706, May and June, 1902.)—In a former paper [see Abstract No. 444 (1903)] the writer proved on certain assumptions (which were of the essence of the theory) that Maxwell's law of distribution of velocities holds for an ideal liquid, as well as for its ideal vapour. In the present paper P denotes the internal, p the external pressure, T the temperature, Δ a small increment of T, and p is assumed small compared with P. This gives—

$$P/P + p = T/T + \Delta \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Again if p be neglected v and v' are the volumes corresponding to T and $T + \Delta$, whence $v' = v(1 + \alpha\Delta)$, α being the coefficient of expansion. Then applying an external pressure p, he obtains $v = v'(1 - kp)$, k being the compression coefficient. From these three equations he deduces $P = \alpha T/k$ (4). He now assumes that Maxwell's law holds not only for an ideal, but also for an actual liquid. And applying the method of the former paper with its assumptions, he obtains $P = pe^{rJ/RT}$ (7), in which the symbols r, J, R have the same meaning as in the former paper. The question arises now whether (4) and (7) are consistent when numerically calculated. Now (7) is formed on the assumption that the molecules of the vapour have the same constitution as those of the liquid. For mercury this is the case, but not for water and certain other liquids. Reference is here made to the researches of Amagat, Colladon, and Sturm. In the next section the writer considers the internal friction of liquids, using the results of a former article [see Abstract No. 75 (1900)]. The method consists in the substitution in the formula for gases, instead of n the number of molecules in unit volume, of the much larger number ν determined in that article. From the result it is possible to obtain experimentally the coefficient of friction, and the internal pressure, and from these to determine the dimensions of the molecules of a liquid. This is done with the result σ the diameter $= 40 \times 10^{-9}$ cm. In the last section he finds a numerical value for the mean free path λ, namely, $\lambda = 6 \cdot 10^{-9}$ cm. S. H. B.

REFERENCES.

904. *New Thermostats.* **F. Grützmacher.** (Zeitschr. Instrumentenk., Beib. 19. pp. 184–187, Oct. 1; 20. pp. 193–196, Oct. 15; and 21. pp. 201–203, Nov. 1, 1902.) —Improved thermostats are here described (1) for ordinary water-baths, (2) for boiling liquids, (3) for boiling water specially, (4) for freezing mixtures, (5) for liquid CO_2. R. E. B.

905. *Variability with Density of Quantity b of State Equation.* **J. D. van der Waals, Jr.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 640–650, Feb. 28, 1903.)—It has been shown that the influence of the extension of a molecule on the form of the state equation, in the case of perfectly hard and elastic spherical molecules, is, in a first approximation, adequately accounted for by deducting from the volume V occupied by the gas four times the volume of the molecules. The author here discusses this first correction term, which by his father (Van der Waals, Versl., &c., V., Oct., 1896) is found to be equal to $17b_\infty^2/32V$. A. G.

906. *Papers on Low-Temperature Research.* **J. S. Shearer.** (Phys. Rev. 15. pp. 243–254, Oct., 1902.)—The author gives a very complete bibliography beginning with the year 1890. G. W. de T.

907. *Liquefaction of Air and Hydrogen.* **K. Olszewski.** (Acad. Sci. Cracovie, Bull. 10. pp. 619–633, Dec., 1902.)—A description is given of new and simplified apparatus for prompt production of liquefied air or hydrogen, both in large quantities and in small (100 c.c.) for lecture demonstrations. In the hydrogen apparatus the spontaneous evaporation of liquefied air is applied, but the quantity used is very small (only 3 litres for 200 to 300 c.c. liquefied hydrogen). A. D.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

908. *Field of Moving Electrons.* **E. Riecke.** (Archives des Sciences, 14. pp. 609–616, Dec., 1902. Paper read before the Société helvétique des Sciences naturelles (Phys. Section), Geneva, Sept. 9, 1902.)—Investigation of the electrostatic potential. The equipotential surfaces are flattened ellipsoids of revolution, whose axes are parallel to the direction of displacement of the electron. The values of the potentials at points along the axes are the same as those which would be due to an electric particle not in motion. If the velocity of displacement of the charge be greater than that of light, the equipotential surfaces are hyperboloids of revolution contained within a cone which is asymptotal to all these hyperboloid surfaces. A. D.

909. *Electric Convection.* **V. Crémieu.** (Journ. de Physique, 1. pp. 753–771, Dec., 1902.)—The question of the direct magnetic effect, and that of the magnetic-inductive effect of electric convection, are far from being cleared up. The author gives a *résumé* of the experimental work done on this subject, the aggregative result of which is very inconclusive, even where positive results have been recorded. The conditions which must be fulfilled are, that the charge must with certainty be carried by the moving conductor; that this charge alone must act upon the apparatus intended to detect magnetic effects attributed to the electric convection; and that, during the transport of the charge, this charge must not lose more than a very small fraction of its amount. When subjected to criticism, it is found that none of the forms of apparatus used have met these conditions, perhaps largely because of secondary phenomena, some of which point towards the existence of nodes of electric oscillation, which are themselves due to variations in the distribution of the charges; and the condition of the dielectric which supports the charged moving conductor is also subject to variations. All these produce disturbing effects, even inside a closed electric screen. There are also anomalies in the distribution of charge borne by insulated conductors on solid dielectrics; and a fresh series of experiments in which these causes of error are kept in view has again led to varying and inconclusive results. There is no clear evidence for any direct magnetic effect of electric convection, but there is much room for investigation of the secondary effects referred to. A. D.

910. *Magnetic Action of Rotating Electrified Sphere.* **A. Szarvassi.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 1053–1065, July, 1902.)—In this article Hertz's vector equations ("Electrodynamics of Bodies in Motion") are taken as fundamental, with the usual impossible-to-be-written symbols for electric force, magnetic force, magnetic induction, &c., and 1/A the velocity of light, and u the velocity of the moving body. This velocity u Hertz assumes to be also that of the medium. In the present article there is assumed a field symmetrical about the axis of rotation. The writer shows that, on the last assumption of Hertz that u is the velocity of the medium, there can be no magnetic action, the normal component of the electric force being not zero when the moving body has a charge, and this leads to results inconsistent with Hertz's equations. Hertz's limiting conditions are inconsistent with his equations of the field. To avoid the difficulty we have only to drop the assumption that the body moves with the medium. And on this new hypothesis the author works out the magnetic force due to a moving sphere with an electric charge. Comparing his result with those obtained by Bezold and Bauer for the earth's magnetism, he finds they agree on the assumption that the earth's charge is negative, and of the order 10^{13} coulombs. So great a magnitude, the author says, is improbable. S. H. B.

911. *Electrostatic Analogy to Diamagnetism.* **L. Puccianti.** (N. Cimento, 4. pp. 408–410, Dec., 1902.)—Just as a magnet attracts a body whose magnetic inductivity is greater and repels one whose magnetic inductivity is less than that of the medium, so does a charged body attract a body whose dielectric constant is greater and repel one whose dielectric constant is less than that of the medium. This last is shown by a charged metallic ball repelling bubbles of air in vaseline oil. A. D.

912. *Electrification in Bubbling Air through Water.* **R. Fischer.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 1013–1037, July, 1902. From the Phys. Chem. Institut of the K. K. Univ., Vienna.)—The results of Kelvin, Maclean, and Galt all support the conclusion that the air-bubbles become negatively, and the water positively charged. The smaller the bubbles, the greater the charges developed with a given quantity of air. Tubes which direct the air-stream downwards give the greatest charges. Forcing the stream of air increases the electrical charges more rapidly than it does the quantity of air passed. The charge is enhanced by lengthening the travel of the bubbles through the water, at first more rapidly, until a certain height has to be traversed; beyond this the increment is small; the expansion of the bubble as it ascends seems to aid this result. Higher temperatures favour higher electrifications. The theory cannot be developed until the influence of all variations in the experiment has been studied. A. D.

913. *Electrification in Bubbling Air through Water.* **E. Alessandrini.** (N. Cimento, 4. pp. 389–402, Dec., 1902.)—Electrification by bubbling air through water follows the same laws as that by spraying liquid jets: the air becomes negative, the water positive. The potential assumed by the water tends to a limit which is the same whether reached by means of rises or falls in the potential of the water, but depends on the quality and quantity of the substances dissolved in the water, the slightest trace of impurity greatly reducing the potential, which, with pure distilled water, may reach hundreds and probably thousands of volts. The quantity of air bubbled through and the quantity of water have no influence except upon the time taken to reach the ultimate value of the potential. In sea-water the electrification is extremely feeble. Some substances, such as colouring matters in solution in the water, even affect the sign of the resultant electrification. There is no electrification unless there is a mechanical fracture of bubbles of air or of a jet of liquid; air driven through wetted wool, &c., does not become at all electrified. A. D.

914. *Electricity Dispersion in the Free Atmosphere.* **J. Elster** and **H. Geitel.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 946–981, July, 1902.)—This is a *résumé*, from the ionic standpoint, of the authors' observations conducted since 1898 at Wolfenbüttel, and periodically during journeys to the

Alps, Italy, Algiers, Denmark, Norway, Spitzbergen, &c. The authors describe their modification of Linss' instrument (of 1887) for measuring the dispersion, refer to the more portable form they afterwards adopted, and regret the necessity for using a cylindrical guard. The dispersion is not the same in an enclosed space as in the open air, and some radio-active influence seems to be at work; for instruments that come fresh from the workshop or have been kept packed up for some time give smaller values than instruments used for days, and working in caves renders the instruments more sensitive. At Wolfenbüttel the ratio of *q* (dispersion coefficient for negative to coefficient for positive charges) is **1·06**, as in general (except on mountains and on sea shores); only near the waterfalls of Hallarmö (Norway) *q* was found less than 1. The rapidity of the negative discharge indicates a predomination of positive ions in the air. There is no distinct temperature influence in perfectly clear air; in dusty air the dispersion seems to increase with higher temperatures, provided the temperatures are not extreme. Humidity has the opposite effect that is popularly assumed; the dispersion is independent of the absolute humidity, but decreases with increasing saturation; this is confirmed by direct experiments, observations on Spitzbergen [see Abstract No. 1706 (1902)], and by Pochettino, and would show that the ions serve as condensation nuclei and are then impeded in their movements. Winds with descending air-currents (foehn, bora) bring very high dispersion, possibly with the strongly ionised air from higher strata. Everything impairing the transparency of the air—mist, smoke, dust, haze—diminishes the dispersion; there may be a static attraction between the ions and the particles. Moderate winds favour the dispersion, which has its daily maximum about noon, and its annual maximum in April, and minimum in January. On mountain-tops (Säntis, Gorner Grat, 3,140 m., &c.) the *q* becomes abnormally high, up to 15 on the Gorner Grat; at Spitzbergen also values up to 2·7 were observed. On mountains this may be due to a polar influence of the earth field; but that would not apply to Spitzbergen, where an excess of positive ions may be assumed as in the air of cellars. The *q* become greater—*i.e.*, the prevalence of the negative discharge more marked—when the cylindrical guard is dispensed with. Within large towns the dispersion coefficients are reduced to ½ or ⅓ of their values in the purer country air. H. B.

DISCHARGE AND OSCILLATIONS.

915. *Emission of Negative Particles from Hot Bodies.* **J. J. Thomson.** (Phil. Mag. 4. pp. 253-262, Aug., 1902.)—After referring to Elster & Geitel's discovery of the emission of negative electricity from a hot wire in vacuo (Wied. Ann. 37. p. 315), and to his own demonstration in 1899, that the carriers of this were identical with those observed in the kathode rays, the author points out that Richardson's experiments [see Abstract No. 1091 (1902)] show an emission from incandescent carbon equivalent to a current of an ampere per sq. cm. of carbon surface. He then considers some of the effects which must arise from so great an emission. The negative particles will, according to the electromagnetic theory of light, be set in motion by light waves, and hence scatter the light. He then calculates the energy of the light scattered in this manner, and shows that it will be polarised as if reflected from small particles, and if the light is homogeneous the spectrum will widen into a band. He suggests that some of the observed phenomena of the solar corona may be due to this cause. He shows that the sun would appear to repel the corpuscles, because the effect of an electromagnetic wave will be to propel them in the direction of the wave. The velocity so communicated would be inconsiderable for the waves of sunlight, but might become comparable with the velocity of light if the sun emitted Hertzian waves of long period. If a comet emitted such corpuscles, they would be repelled by Hertzian waves from the sun, and appear as a luminous tail behind the comet. The emission of these corpuscles from a hot body involves the existence of streams of corpuscles within the body—streams of kathode rays in fact. Their collision with the molecules would therefore produce electromagnetic pulses, but on account of the comparatively low velocity, these would be much "softer" than the Röntgen rays produced in a vacuum tube. A succession of sufficiently broad pulses would produce a continuous spectrum of the kind given by a hot body, and this part of the radiation would have the characteristic property of increasing rapidly with the temperature. G. W. DE T.

916. *Electrical Discharge from Hot Carbon.* **C. D. Child.** (Phys. Rev. 15. pp. 345–354, Dec., 1902.)—When a carbon pencil is heated the positive discharge occurs first whether the carbon is heated in air at normal pressures, in a vacuum, or in hydrogen. In air it requires only a slight increase in temperature to produce the negative discharge. At higher temperatures the negative discharge is the greater. Both positive and negative pass through maxima as the temperature is raised. In an enclosed tube the discharge is much smaller than in open air. In a vacuum the negative discharge becomes many times greater than the positive at higher temperatures, and the rates of discharge do not here pass through maxima. In general the discharge from hot carbon behaves like that from hot platinum. The velocity of the ions is diminished by reason of the presence of particles driven off from the carbon. It is probable that the smaller velocity of the negative ions is due to their being loaded more than the positive by these particles.

W. C. H.

917. *Oscillatory Discharge of Condenser with High Resistance in Circuit.* **H. Tallqvist.** (Ann. d. Physik, 9. 5. pp. 1083–1099, Dec., 1902.)—When account is taken of the conductivity of the insulating layers of the induction coil and of the dielectric of the condenser, theoretical values are obtained for the logarithmic decrement of the oscillations which agree very closely with experiment even with high values for the resistance in the circuit; and further, theory and experiment correspond very closely in relation to the transition from oscillatory to a periodic discharge. A. D.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

918. *Definitions Relating to Conducting Systems.* **F. Breisig.** (Elektrotechn. Zeitschr. 23. pp. 1137–1139; Discussion, pp. 1139–1140, Dec. 25, 1902. Communicated by the Kais. Telegraphen-Versuchsamt, and read before the Elektrotechn. Verein, Oct. 28, 1902.)—The author calls attention to certain loose expressions representing, or purporting to represent, the various quantities involved in calculations of the capacity and self-induction of conductors, particularly in relation to cables containing two or more conductors. He attempts to bring the various cases into conformity by referring them to the ideal single conductor far removed from other conductors. He suggests

the following definitions: The quantities as denominated should refer to the properties of an individual conductor, and not to the system as a whole. By the term "resistance" is thus to be understood the resistance of some particular component conductor. The "self-induction" is to be understood to mean the number of lines of force which this observed conductor cuts when unit current begins or ceases in it, it being premised that the appropriate currents are at the same time acting in the other components of the system. The "capacity" is to be referred in like manner to a single component conductor, and is to be measured by the ratio of the quantity of electricity associated with that component at a given potential, to that potential, when the other components are at their appropriate potentials. By the term "potential" is always to be understood the potential difference referred to zero. R. A.

919. *Conductivity and Polarisation in Dielectrics.* **E. R. v. Schweidler.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 579–592, May and June, 1902. From the Phys. Chem. Institut of the K. K. Univ., Vienna.)—In different kinds of glass, the resistance, when a stationary value of the current through the glass has been reached, is independent of the electromotive force; at higher temperatures the quantity of electricity passed by discharge of the polarisation of the dielectric is increased, but not in proportion to the conductivity, so that the period of polarisation of the dielectric remains unaltered. In different badly-conducting liquids and in different kinds of paper the polarisation is unimportant in comparison with the variations in the resistance that are caused by the passage of the current. The stationary final values of the current are not proportional to the electromotive force; and the departures from proportionality are in one sense for liquids and in the other for paper. Paper as a dielectric offers some peculiarities in the time-relation of the current strength after commutation of the current. A. D.

920. *Anisotropic Dielectrics.* **A. Lampa.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 982–995, July, 1902. From the 1st Physik. Inst. of the K. K. Univ., Vienna.)—A theory of anisotropic dielectrics is developed on the assumption of unequal densities, and corresponding distribution of the conducting particles, in three axial directions. The theory leads to a value 2·747 for the dielectric constant of rubber at right angles to the direction of stretching, while the observed value was 2·727. A. D.

921. *A Simple Method for the Determination of Dielectric Constants.* **J. Billitzer.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 814–822, May and June, 1902. From the Phys. Chem. Institut of the K. K. Univ., Vienna.)—The substance whose dielectric constant D_x is required, is suspended in a liquid of known dielectric constant D_l. From the induction effect produced by two charged parallel platinum wires suspended vertically behind the substance in the liquid, the author determined the nature and amount of deflection, the sign of the deflection being positive, zero or negative, according as $D_x \overset{>}{\underset{<}{=}} D_l$. If D_x is greater than D_l the suspended body is attracted towards the platinum wires; by alteration of the constituents of the liquid so as to vary the value of D_x, the values of D_l are obtained by means of interpolation. The vertical platinum wires are connected with an induction apparatus having a motor mercury interrupter, the alternating current being used to avoid polarisation effects. The substance under test is, if possible,

drawn out to a fine thread and fixed by a drop of collodion to a short quartz suspension fibre, the movement of the thread being observed with a microscope having a micrometer eyepiece. To obtain a wide variation in the dielectric constant, the liquid chosen is a mixture of acetone and hexane, giving a range from 1·85 to 20·44. A mixture of ethyl ether and benzol is also recommended. The following results with glass show the method of calculation :—

Composition of Liquid.		Dielectric Constant of Liquid.[1]	Deflection of Glass Filament.
Hexane 1	Acetone 0	1·85	−10
„ 9	„ 1	3·46	− 2·5
„ 6	„ 1	4·2	+ 2
„ 4	„ 1	4·81	+ 5
„ 3	„ 1	5·9	+10
„ 0	„ 1	20·44	+ 22 to + 29

[1] These constants are measured by Nernst's method.

On plotting the results on a curve the value of D_1 for glass is 4·0. In the case of sulphur the constant is 3·8 ; sealing wax, 4·5 ; silk, 1·6. The method is suitable for obtaining the dielectric constants of small quantities of substances to a fair degree of accuracy ; by using fibres with known constants the value of D_x for different liquids may also be determined. E. S. A. R.

922. *Electrostriction of Glass.* **A. Wüllner** and **M. Wien.** (Ann. d. Physik, 9. 5. pp. 1217–1260, Dec., 1902.)—The increase in the internal volume of spherical and cylindrical condensers, due to electrostriction of the glass, is in general smaller than the coefficients of elasticity (as determined by acoustic experiments or by means of compression) would indicate. The difference is greatest in flint glass, least in Thuringian glass. The after-effect after discharge, observed by Quincke and Cantone, which slowly passes off and lasts the longer, the longer the preceding charge had continued, is due to the expansion of the glass through Joule heating. The coefficient of elasticity of glass as determined by compression is generally a little less than that found by acoustic methods ; the difference being greatest in flint and least in Thuringian glass. A. D.

923. *Carbon Resistances.* **A. C. Longden.** (Phys. Rev. 15. pp. 355–365, Dec., 1902.)—The author describes a method of making carbon resistances of clay and graphite moistened with sugar solution; the moist clay thus formed is pressed into cylindrical sticks about 5 mm. in diameter, baked in an oven and then carbonised by keeping them at red heat about eight hours in a covered crucible packed with graphite. The graphite in the mixture may be omitted, in which case the sticks are of higher resistance. The best form of contact for the ends is to wrap several turns of fine copper wire round them, and make this wire the kathode in a copper-depositing cell. The copper is at first deposited only on the wire, but in a short time it creeps over the surface of the clay-carbon stick and soon forms a perfect coating over as much surface as is immersed in the bath. A better form of carbon resistance is made by silvering the ends of a glass strip by chemical means, and then covering the glass slip with smoke, preferably from burning camphor ; these smoke films may be hardened by exposure to alcohol vapour, after which they may be covered with shellac or rubber varnish or coated with paraffin wax. All carbon resistances increase in resistance with age, but the smoke-film ones considerably less than the clay-carbon cylinder ones, and the former become practically constant after about a year's time. E. C. R.

924. *Improved Form of Capillary Electrometer.* **G. J. Burch.** (Roy. Soc., Proc. 71. pp. 102–105, Dec. 27, 1902.)—The capillary electrometer must be simple, easy to adjust and clean, and not liable to be broken when used with reasonable care. Above all, it must be suitable for use with objectives of short focus and wide-angle condensers. The author has devised many different forms of electrometer intended to satisfy these conditions, and in the present paper he describes the most recent improvements. In the type hitherto favoured by the author the capillary was placed within a piece of thick-walled burette tubing of 1 mm. bore, half ground away so as to form a trough of semi-circular section, and with a cover-glass as front [see Abstract No. 102 (1903)]. This type gave excellent results, but there was a difficulty in adjusting the capillary. The author has therefore changed his plan for one in which the safety of the capillary depends not on the rigidity of the supports by which the trough is fixed, but on their perfect flexibility, and on the use of a trough so light that its entire weight might even be borne by the capillary. The trough is made from two flat pieces of mica placed one on top of the other. One of them has a long narrow slot cut down the centre for about three-fourths of its length; the other has the same length as this slot and has a V cut out at the part coinciding with the top of the slot, and a semicircle of diameter equal to the width of the slot, cut out at the part coinciding with the bottom of the slot. These two pieces of mica, thus forming a trough, are fastened together by loops of Pt wire at the four corners, and the whole is suspended by long-link chains of Pt wire, so that the capillary attached to the pressure apparatus rests against the centre of the trough. For adjustment, the apparatus can be tilted back at each operation so that it is free of the capillary. When the inside of the trough has been wetted, the apparatus is tilted forward until the trough touches the capillary and sticks to it. A piece of thin cover-glass, slightly wider than the trough, is then wetted on one side with acid and placed carefully against the trough, holding it firmly against the capillary, the lower edge of the glass resting against the Pt loops with which the trough is fastened together. The wide end of the U-tube into which the trough dips is then brought up underneath until the lower edge of the glass just dips into the acid, when the tube is clamped. Finally, the trough is gently shaken until the acid rises in it to the required height and all bubbles are expelled. These electrometers give perfect definition. The capillary touches the cover-glass throughout its length, so that any dry objective can be used. W. C. H.

ALTERNATING CURRENTS AND MAGNETISM.

925. *Action of a Magnetic Field on the Anode Column.* **H. Pellat.** (Comptes Rendus, 135. pp. 1321–1324, Dec. 29, 1902.)—The general method and the results of the author's previous experiments have been described fully [see Abstract No. 1872 (1902)]. In the present paper investigation is made in the vacuum tube on pure hydrogen and pure oxygen, and on a mixture of the two gases. The resistance to the anode- or cathode-stream across the lines of force the author calls magnetofriction; and he shows that

magnetofriction is much less pronounced in oxygen than in hydrogen for the same pressures and fields. The mixture behaves like a gas having properties intermediate between those of the components. P. E. S.

926. *Minimum Impedance of an Inductive Coil.* **Chaikevitch.** (Assoc. Ing. Él. Liége, Bull. 3. pp. 20–23, Jan., 1903.)—It is known that, although the effective p.d. applied across the terminals of an ironless inductive coil is kept constant, yet the magnitude of the current in it varies with the shape of the current wave. The author applies the calculus of variations to find out whether the current will be an absolute maximum for any particular shape of wave. In symbols, the problem is to find the maximum value of $\int_0^T i^2 dt$ when i satisfies the equation,

$$V^2T = r^2\int_0^T i^2 dt + L^2\int_0^T \left(\frac{di}{dt}\right)^2 dt.$$

Equating the first variation to zero we find that the extreme values of i are given by—

$$(\lambda + r^2)i - L^2\frac{d^2i}{dt^2} = 0$$

where λ is an undetermined multiplier. This equation admits of three solutions, but the only periodic one is $i = I\sin(\omega t - \alpha)$. The calculation of the second variation is extremely complicated, and so the author proves by general reasoning that the above solution makes the effective current and therefore also the power expended a maximum. A. R.

927. *Hall Effect and the Velocities of Ions of Salt Vapours.* **G. Moreau.** (Comptes Rendus, 135. pp. 1326–1328, Dec. 29, 1902.)—Marx [see Abstract No. 2211 (1900)] has measured the coefficient of rotation, R, due to the Hall effect for flames charged with KCl at different concentrations, and with NaCl. Interpreting R by the ionic theory, the author developes the approximate formula—

$$R = K_2 - K_1 \text{ ....(1),}$$

K_2 and K_1 being the mobilities of the positive and negative ions. Comparing the results of Marx with the values obtained by himself for K_1 and K_2, the author finds that this formula is sufficiently close to the truth when we make proper allowance for the differences of temperature at which the mobilities and R were observed, and that it furnishes a kinematic interpretation of the Hall effect, which experiment verifies. Marx has also developed the formula $R\sqrt{M} =$ constant, where M is the molecular weight of the metal, and from this formula and (1) we get, as K_2 is much smaller than K_1—

$$K_1\sqrt{M} = \text{const. ....(2),}$$

which also confirms what experiment has shown, that the negative ion only depends on the metal of the vapour. The author considers it to consist of a nucleus, formed by the dissociation of the metallic atom, which groups around it other non-ionised atoms increasing in number with the concentration. The positive ion will then be the remainder of the atom along with molecules of the medium burning in the flame. This would explain the preponderating influence of the metal in the conductivity of salt vapours, which has been observed by Arrhenius. W. C. H.

928. *Change of Length and of Thermoelectric Power by Magnetisation.* **E. Rhoads.** (Phys. Rev. 15. pp. 321–326, Dec., 1902.)—A thermopile is constructed of wires in the following complete cycle: iron, alloy, copper, alloy. A great many such cycles being placed in series, alternate ends are heated and cooled by steam and cold-water jackets. The alloy mentioned is of bismuth and antimony and serves to neutralise the thermoelectric effect of the iron and copper junctions so as to give no thermoelectric force on the whole when no magnetic field acts on the system. On placing the whole in a solenoid and passing current, thermoelectric force is produced—which, as the field due to the current increases, first increases to a maximum (M_1), and then diminishes. If the last strong field be reduced gradually, the thermoelectric force increases, attains a maximum (M_2) greater than before, and then, when the field is nil, still remains large. By reversing the field, a complete cycle of a hysteresis nature is obtained. This curve of field and thermoelectric force the author gives, and he shows that it is similar to the curve between field and change of length for the same iron as that used in the experiments above. But the latter curve is not the usual experimental curve; it is obtained by applying the correction for the Maxwell stress $B^2/4\pi$ to the curve. Testing nickel instead of iron the author observes a similar likeness between the two relations. Strain causes a change in thermoelectric power, and so it may be that the strain set up by the magnetisation may produce the changes in thermoelectric force and explain the results.

P. E. S.

929. *International Magnetic Observations during the Total Solar Eclipse of May* 18, 1901, *and Previous Eclipses.* **L. A. Bauer.** (Terrestrial Magnetism, 7. pp. 155–192, Dec., 1902.)—During the total solar eclipse of May 28, 1900, a slight magnetic effect, directly associated apparently with the passage of the shadow cone, was observed within and close to the belt of totality in the United States. The effect was not of the nature of a magnetic disturbance; it was not cosmical, because not simultaneous for different regions, but its cause seemed to be outside the earth's crust. International co-operation was hence agreed upon for the eclipse of May 17–18, 1901. The track of the shadow cone extended in a curved belt from Madagascar across Mauritius, the Indian Ocean, Sumatra, and Borneo to New Guinea. That it was in the southern magnetic hemisphere was fortunate, the previous eclipse having been in the northern hemisphere; but there were only three observatories available—on Mauritius, and at Karang Sago and Sawah Loento, on Sumatra; further at Batavia, 350 miles south of the belt, and Manila, 1,000 miles to the north of it. Check observations were conducted at twenty-eight stations all over the globe; the instructions which the author issued for this purpose in the United States have been mentioned in Abstract No. 1724 (1902). The results tabulated in the paper show that during the interval of the observations, viz., May 17, 1902, 14 h. to 21 h. (Greenwich mean astronomical time), there was no general magnetic disturbance. In the belt of totality a marked eclipse effect was noticed, especially in the generally most susceptible horizontal intensity, which decreased on Mauritius and Sumatra, and at Batavia, and increased at Manila, which is in the opposite magnetic hemisphere. Vector diagrams are reproduced. The paper further refers to the previous eclipses of December 22, 1870 (observed in Sicily), December 12, 1871 (Batavia), May 28, 1900 (United States); these records are grouped according to local time. It results that the eclipse magnetic variation is opposite in the two magnetic hemispheres, and opposite for the morning and the afternoon hours, and therefore in nature analogous to the diurnal variation, differing only in degree. The probable cause of the eclipse effect is the cutting off by the moon of certain rays (kathode rays, *e.g.*) in the upper atmosphere. As the earth itself always eclipses one of its sides, we should have a similar diurnal effect. If the magnitude of the effect on the range of declination variation, for instance, be proportional to the amount of sunlight a body is able to cut off, then—the distance of the earth and moon from the sun being practically equal—the earth effect should be to the moon effect as the squares of their diameter, *i.e.*, as $3{\cdot}67^2 : 1$ or as 13·5 : 1. The diurnal range at Rocky Mount (North Carolina) was 10·8′ (eclipse of 1900), the eclipse effect should hence be 0·8′; the observed value was 0·9′. For Mauritius and Batavia and the 1901 eclipse the computed (observed values) are 0·5 (0·6) and 0·4 (0·7)′. The author further examines whether the seasonal change in the diurnal range of the magnetic declination is related to the varying diurnal intensity of solar radiations. Calculations of the ratio of mean diurnal range of magnetic declination in the summer months to the means of the winter months agree with observations for three American stations and for Mauritius, but not for Potsdam; these latter observations and calculations concern different periods. H. B.

930. *Magnetic Observations on Land by the Austrian Navy between* 1896 *and* 1901. (Terrestrial Magnetism., 7. pp. 196–198, Dec., 1902. Abstract.)—The Austrian ships *Albatros, Freundsberg, Saida,* and *Donau* took magnetic measurements on shore during their cruise at twenty-eight spots in the East Indies, Eastern Asia, Australia, Honolulu, Africa, and South America. The results are tabulated in this paper; full particulars in Veröffentlichungen des Hydrographischen Amtes, Pola; Gruppe IV., Erdmagnetische Reise-Beobachtungen. III. Heft. Pola, 1902, 52 pp. H. B.

REFERENCES.

931. *Dispersion of Electricity in the Free Atmosphere of Capri.* **V. Cuomo.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 6. pp. 324–353, 1902.)—Report on the continued observations, March to Sept., 1902 [see also Abstract No. 2072 (1902)]. H. B.

932. *Curve-tracing Instrument.* (Amer. Inst. Elect. Engin., Trans. 19. p. 1174, Aug. and Sept., 1902.)—Discussion at Great Barrington on paper dealt with in Abstract No. 2089 (1902).

933. *Current Distribution in a Network of Conductors.* **W. Feussner.** (Ann. d. Physik, 9. 5. pp. 1304–1329, Dec., 1902.)—The author discusses the general laws of Kirchhoff and Maxwell, and indicates the method of treatment in cases of imperfect network systems. E. S. A. R.

934. *Industrial Magnetic Measurements.* **Armagnat.** (Soc. Int. Elect., Bull. 2. pp. 714–753, Nov., 1902.)—After a brief account of the principles involved, the author discusses the long list of permeameters in the market. Then he compares the hysteresimeters of Ewing and Blondel. P. E. S.

935. *Electrolysis of Metallic Salts in the Organism.* **A. Poëy.** (Comptes Rendus, 135. pp. 874–876, Nov. 17, 1902.)—The author recalls a paper in the Comptes Rendus for 1855 in which he described how to extract metals from the system of a patient by passing a current through his body into the liquid of an acidified bath. The metal travelled with the current, traversed the skin, and was found in the acidified bath. A. D.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

936. *Formation of Oceanic Salt-Deposits. Temperature of Formation of "Hard-Salt."* **J. H. van't Hoff** and **W. Meyerhoffer.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 52. pp. 1106–1109, Dec. 11, 1902.)—The temperature at which the natural salt-beds were deposited can be determined by the presence of: (1) minerals such as langbeinite and loeweïte, which cannot be formed *below* 37° and 43° respectively; (2) minerals which cannot exist *above* a definite temperature; (3) combinations of minerals which can only exist together within definite temperature limits. An example of the last class is "hard-salt," an intimate mixture of sylvine (KCl) and kieserite ($MgSO_4$, H_2O) with common salt. At ordinary temperatures these combine to form kainite ($MgSO_4$, KCl, $3H_2O$), which can exist in contact with excess of kieserite or excess of sylvine, but the latter cannot exist uncombined in contact with the same solution. The temperature at which kainite dissociates into sylvine and kieserite in a solution saturated with common salt was therefore determined, and found to be 76° by the dilatometer and 72° by the tensimeter. This, therefore, is the minimum temperature at which "hard-salt" can be formed.

T. M. L.

937. *Argon and Free Sulphur in Natural Springs.* **H. Moissan.** (Comptes Rendus, 135. pp. 1278–1283, Dec. 29, 1902.)—The author's attention was directed to these springs by their therapeutic effects. In the first, *Source Borden*, No. 1, the sulphurous water issues from longitudinal fissures in the schistous rock at a temperature of 44° C. The gas, when collected without contact with air, hardly affected the surface of mercury, and was found to contain no trace of SH_2. This seems to indicate that the sulphurous water of the Borden Spring does not contain hydrosulphate, for otherwise it would produce SH_2 by dissociation. The moment that the water of the spring comes in contact with the CO_2 of the air, SH_2 appears. The free gas collected contained no CO_2, nor were there any traces of O. It consisted of a small quantity of methane, a great quantity of nitrogen, and a little argon. A spectral analysis of the argon did not reveal the presence of helium. The Grotto Spring was found to contain sulphur in solution, while the vapour emanating from the inhalation tubes contains very small quantities of sulphuretted hydrogen, sulphurous acid, and volatilised sulphur, the latter being derived from three sources: (1) the slow combustion of sulphuretted hydrogen, (2) the reaction of a small quantity of sulphurous acid upon the sulphuretted hydrogen, and (3) vaporisation of sulphur in solution in the water. This sulphur vapour may play a part in the therapeutic action of the inhalation, either as an antiseptic or owing to the facility of its assimilation.

G. G.

938. *Action of Alkalies on Glass and on Paraffin.* **F. Jones.** (Manchester Lit. and Phil. Soc., Mem. 47. 3. pp. 1–17, Dec. 15, 1902.)—In order to test whether in Pettenkofer's method of determining carbon dioxide in air any of the alkali might be neutralised by the silica of the glass, lime, strontia, and baryta water were enclosed (1) in plain glass bottles, (2) in bottles containing 0·1 gr. silica, and (3) in bottles containing 1 gr. powdered glass. In the course of six months the lime-water had lost 13 per cent. of its alkalinity in the plain bottle, but the strontia and baryta were unaltered; in the bottles containing silica and powdered glass all the alkalies were much reduced in strength, but here again the effect was greatest in the case of the lime-water, which in the course of a few months was almost completely neutralised by the silica. Sometimes the bottles are lined with paraffin wax in order to prevent the action of the alkali on the glass; for some little time no action occurs, but ultimately the action is (at least in the case of baryta) very much greater than the action on the plain glass. In a test experiment, in which alkaline solutions were left in contact with paraffin shavings during five months, the lime-water lost 22 per cent., the strontia 30 per cent., and the baryta 99 per cent. of its alkalinity; the solution contained no organic matter, but the alkali was found to be associated with the paraffin. T. M. L.

939. *Oxidation of Alcohol and Aldehyde.* **J. Slaboszewicz.** (Zeitschr. Phys. Chem. 42. pp. 343–352, Dec. 23, 1902.)—When aldehyde is warmed with water, it undergoes autoxidation, one portion of the aldehyde being oxidised to acetic acid at the expense of another portion which is reduced to alcohol. As the author shows, the diminution of the free energy in the oxidation of aldehyde to acid is greater than in the oxidation of alcohol to aldehyde, as is also shown by measurements of the electric potential both in alkaline and acid solutions. The author also discusses the oxidation of alcohol by potassium ferricyanide in alkaline and acid solution. In acid solution, the difference of potentials for potassium ferricyanide and for alcohol is 0·091 volt; in alkaline solution, 0·956 volt, so that it is not to be wondered at that oxidation occurs instantaneously in alkaline solution. A. F.

940. *Combustion in Oxygen of Three Varieties of Carbon.* **H. Moissan.** (Comptes Rendus, 135. pp. 921-928, Dec. 1, 1902.) — Experiments upon diamond, graphite, and amorphous carbon are described. The combustion of the different varieties takes place at temperatures which increase with the degree of polymerisation of the carbon. Diamond becomes incandescent at 800–875°, graphite at 650–700°, amorphous carbon at 300–500°. Each of these vigorous reactions is preceded by a reaction slower in proportion to the distance of the temperature from the combustion point. J. W. P.

941. *Transformation of Diamond into Black Carbon by Oxidation.* **Berthelot.** (Comptes Rendus, 135. pp. 1018–1020, Dec. 8, 1902.) — An account of observations in which the diamond is burnt incompletely in pure and dry oxygen is given. Graphite is formed. The question is raised whether the transformation results from the action of the high temperature alone or from an isomeric change at the moment of combination. Similar phenomena in the case of other substances are described. J. W. P.

942. *Formation of Layers in Solutions. Pseudomolecular Compounds.* **A. Sinding-Larsen.** (Ann. d. Physik, 9. 5. pp. 1186–1197, Dec., 1902.)—If in a solution of which the concentration increases from the top downwards a difference of temperature is established along a vertical strip of the containing vessel (*e.g.*, by contact with a strip of hot copper or cold, trickling water), the whole mass of liquid breaks up into a series of separate layers which are especially prominent if the difference in refractive index is sufficient to permit of total reflection. The boundaries are not horizontal, the slope, as well as the sharpness of the boundaries, being determined by the temperature-gradient and the limits between which the concentration varies. There is a continuous circulation in each layer, and the layers gradually increase in thickness and decrease in number. T. M. L.

943. *Velocity of Solution of Solid Bodies.* **L. Bruner** and **S. Tolloczko.** (Zeitschr. Anorg. Chem. 35. 1. pp. 23–41, April 30, 1903.)—In a previous paper [see *id.* 28. p. 314, also Abstract No. 405 (1901)] the authors began a methodical investigation into the factors controlling the velocity of solution of solid bodies, viz.: (1) The speed the solvent water is stirred at; (2) the volume of the solution. As, however, the arrangement then adopted did not allow of more than 400 turns per minute being obtained, they now describe two other methods, enabling the speed of stirring to be driven up to figures as high as 950 and 2,200 turns per minute respectively. The results of these experiments tend to show that the constants of the velocity of solution are practically proportional to the speed of rotations up to about 9 m. per second. The amount dissolved is proportional to the speed of the gliding water, no evidence as to the existence of a maximum velocity being found. As regards the influence of the volume of the solution, previous experiments had failed to detect any influence of this sort. In this paper, however, the constants of the velocity of solution are found to be inversely proportional to the volume, though for higher speeds of rotation some disturbing factors may impair the results. The authors finally give some theoretical deductions from their experiments, it being suggested that the velocity of solution be defined as the amount dissolved by the unit (1 sq. c.) of surface in the unit of time (1 hour), the surface being washed by a current of pure solvent of any constant velocity. A. G.

944. *Relation between Negative Pressure and Osmotic Pressure.* **G. A. Hulett.** (Zeitschr. Phys. Chem. 42. pp. 353–368, Dec. 23, 1902.)—The term "negative pressure" is used to denote the force which tends to increase the volume of a liquid without changing its temperature, and the author gives a summary of the work done since Berthelot's demonstrations in 1850. The author performed some experiments similar to those of Askenasy; a tube 2 metres long was closed at the upper end by a porous plate containing a semipermeable membrane of copper ferrocyanide, filled with de-aërated water and inverted in a mercury trough. The water evaporated from the porous plate on top, and mercury rose in the tube till a height of 1,111 mm. of Hg (347 mm. more than the barometric height) was reached before the liquid broke away from the plate; it was found that the rate of evaporation of the liquid from the porous plate diminished as the experiment proceeded, *i.e.*, the vapour pressure became less as the "negative pressure" increased. Osmotic pressure may be considered as a "negative pressure"—a pressure exerted by the dissolved substance on the solvent and tending to increase the volume of the latter. On this assumption a quantitative expression may be found for the relation between osmotic pressure considered as a negative pressure and the lowering of the vapour pressure. By considering a relevant cycle of operations, we find that $P = -V\Delta p/\psi(d-g)$, where P = osmotic pressure, d = weight of 1 cc. of the solution, g = weight of dissolved substance in 1 cc. of solution, Δp = lowering of vapour pressure, ψ = molecular volume of water, V = molecular volume of water vapour. D. H. J.

945. *Equilibrium between Urea and Ammonium Cyanate.* **J. Walker.** (Zeitschr. Phys. Chem. 42. pp. 207–208, Dec. 9, 1902.)—C. E. Fawsitt in his paper on the decomposition of urea in aqueous solution states [see Abstract No. 515 (1903)] that with rise of temperature there is displacement of the point of equilibrium, so that at the higher temperature there is a larger formation of cyanate. The author points out that this result is in accordance with his own observations, and that Fawsitt's supposition to the contrary rests on a misunderstanding. Indeed the author's experimental results may be deduced from those of Fawsitt by applying the van't Hoff equation

$$4{\cdot}6(\log_{10}K_2 - \log_{10}K_1) = q\left(\frac{1}{T_1} - \frac{1}{T_2}\right).$$

D. H. J.

946. *Electromotive Force of Alloys of Tin, Lead, and Bismuth.* **E. S. Shepherd.** (Journ. Phys. Chem. 7. pp. 15–17, Jan., 1903.)—The author has already shown that tin crystallises pure from a melt containing either lead or bismuth, while lead and bismuth form two series of solid solutions, the limiting concentration being about 10 per cent. in each of the solid phases [see also Abstract No. 676 (1903)]. These conclusions, which were based on quantitative analysis and were in accord with the freezing-point curves, the density relations, and the appearance under the microscope, have now been confirmed by measurements of the electromotive force of the bismuth-lead alloys. A. F.

947. *Glowing Electrolytic Bodies.* **E. Bose.** (Ann. d. Physik, 9. 5. pp. 1061–1069, Dec., 1902.)—The author has already shown that the conduction in the filament of a Nernst lamp is electrolytic [see Abstract No. 1887 (1902)]. He now notices that when the glowing filament is in a vacuum, there is an intense blue light surrounding it, provided the current be continuous. With alternating currents this does not appear. It was at first thought that Rayleigh's theory of the blue sky would explain the results, afterwards a theory depending on conduction through the surrounding rarefied gas; neither of these was, however, satisfactory. The following, however, is thought to be the true explanation: when the continuous current passes, electrolysis occurs, and an atmosphere of metallic vapour is formed, which conducts better than the pure gas, and it is the current passing through this which causes the light. The paper concludes with the results of some experiments on tubes having electrolytes as electrodes. In every case definite chemical separation is found. The author thinks that this supports the theory of G. C. Schmidt and others concerning the changes which take place in solids when bombarded by kathode rays. R. S. W.

REFERENCES.

948. *Theory of the Action of Halogens on Alkalis.* **F. Foerster** and **E. Müller.** (Zeitschr. Elektrochem. 8. pp. 921–926, Dec. 18, 1902. From the Elektrochem. Laboratorium der Technischen Hochschule at Dresden.)—A discussion of the action of halogens on alkalis from the point of view of the law of mass action. A. F.

949. *Aluminium as a Reducing Agent in Metallurgy.* **G. P. Scholl.** (Electrochem. Ind., Philadelphia, 1. pp. 175–178, Jan., 1903.)—This is mainly an account of the process of reducing refractory oxides by mixing them with finely-divided aluminium, and enkindling the mixture with a fuse. The thermo-chemical explanation given by Goldschmidt (Zeitsch. Anorg. Chem. 1902, 699) is also referred to at some length. W. G. M.